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EDITORIAL

Perishables

N THE symposium by Messrs. Yerkes, McKibben and Baker, opening on the page opposite, a few facts step forth as another challenge; not to agricultural engineers alone, but to all their allies in agriculture — agronomists, horticulturists, plant breeders, nutritionists and economists. In particular we mean the dependence of human nutrition on perishable products, and the dependence of these on too-cheap human labor.

Just as the whimsies of the lamented Will Rogers revealed him as one of the wise men of his time, so do the darts of Mr. Baker despite their aura of orotundity define the deficiencies of our approach to agricultural problems both technically and politically. We must confess that we have been pointing with pride to our progress in the things that are easy, and turning our backs on the things that are hard.

There is bitter irony in the circumstance that the abundant life, nutritionally speaking, is possible only by the drudgery of men, women and children who have no abundant life, nutritionally or otherwise. This probably is true not only in such sociology and economics as can be defined by the sign of the dollar, but in terms of social contribution and any rational reward therefor. Any sound solution must come not by paying people more than their product is worth, but by enabling them to produce it in greater volume at lower cost.

Backward as it may seem, it is probable that for some crops success will come sooner by breeding plants to fit the machine than by inventing machines to fit plants which have evolved with no direction toward machine methods. We have precedent in the creation of canning-pea varieties which mature evenly, and to some extent in the breeding of corn and wheat to fit the picker and the combine. As engineers our job will be to foresee a practical machine, then give the geneticist the specifications of a plant to fit it. They may create blueberries that can be combined.

Rural Industry, a Challenge

NE of the fields of agricultural engineering is doubtless that of so-called "rural industry" — a term I use because I know of no brief expression which better describes what I mean. Of our total population the farm segment comprises about one-fourth, and the non-farm rural segment about another fourth. Though the segments are of similar size, the rural segment remains a sort of stepchild in our national economy.

This rural segment is definitely dependent on and related to farming, and I think it generally is considered as agriculture. Much of the time, however, this rural segment is left out of our thinking as we contemplate the national economy. It is not agriculture in the sense that the farmer represents agriculture; it is not industry, although among the segment are many individuals who represent industry or so-called big business; it is not labor. Significantly, in relation to the problem and the opportunity which it presents to our profession, it is not too articulate a segment.

It is my belief that rural industry awaits the engineer for its development and growth. Awaiting the engineer, it in turn awaits commercialization of equipment for its needed development. This equipment, engineered to the requirements of rural industry, will not come from present industrial suppliers of somewhat similar apparatus, in my opinion for the reason that as a rule these suppliers cater, or at least tend to cater, to city industry wherewith this rural-industry counterpart is looked upon as somewhat a competitor.

The farm equipment industry, on the other hand, might and does assume some minor responsibilities for rural-industry equipment. The tendency, however, is to begin with field equipment and to end with farmstead equipment.

Whether either group does this job and assumes its engineering responsibility depends on the engineers' outlook in these groups. In my opinion it calls for some new thinking by the group which feels that the job belongs to it. As now appears, I think it may as well be the agricultural engineer's job, primarily because rural industry deals with agricultural raw materials, and in many cases the operations are such as to prepare them for the farm consumer; that is, the product goes directly back to the farmer. The hybrid seed corn industry is a good example of this. On the other hand, such rural industries as canning plants and hemp processing plants work with products destined for the city as well as the farm.

Perhaps the farm equipment industry has not yet realized that it has the better background and potential approach to the job to be done. Possibly I am remiss in not, as yet, urging it directly upon the attention of this industry. I incline to the view that the initial avenue of broad approach should be through the agricultural engineering profession. Consequently I commend this great challenge to consideration by the membership of the American Society of Agricultural Engineers in general, and in particular to those charged with choosing the areas of subject matter for discussion at Society meetings.

FRANK J. ZINK

Vertical Diversifications

ITTING for consideration by engineers at the same time as the editorial by Mr. Zink is a proposal by D. Howard Doane, well known to agricultural engineers and a leader in the profession of farm management, set forth in a recent issue of "Farm Journal."

What Mr. Doane calls vertical diversification is no new idea to those who have heard him and others, notably in round tables on utilization of farm residues, discuss the desirability of processing farm products as far as feasible right on or close to the farm — and of pushing feasibility farther by engineering development. This technical phase is founded naturally on the efficiency of separating at the earliest possible point the elements which are to go into national commerce from those which should remain on or return to the farm.

In the present reference, however, Mr. Doane emphasizes not technical efficiency but market strategy. He foresees future surpluses of man power, of farm production, and of factory capacity. Whatever its advantages in other ways, horizontal diversification will not cope with such a situation. With it alone, he says, "a farmer stays a raw producer, and in any line the raw producer, unless tightly organized, is the poorest-paid man in the picture . . . . . because there is such a multitude of producers all competing with one another, and all forced to go on whether the price is high or low."

Just how far farmers should carry their products toward the ultimate consumer and his *(Continued on page 70)*

AGRICULTURAL ENGINEERING

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New Farm Machinery Developments Needed

[A SYMPOSIUM]

Paper by Arnold P. Yerkes

MEMBER A.S.A.E.

THE answer to the question under discussion depends upon whether we consider existing equipment merely from the standpoint of its possibilities or from its present actual or practical performance, economic as well as mechanical.

To illustrate, take corn machinery. For the past twenty years or so we have boasted that we have power equipment for the production of the corn crop from seedbed to crib. During this period thousands of farmers have grown large acreages of corn without the corn being touched by human hands.

However, it is reported that about six out of every seven acres of the corn crop in this country are still harvested by hand, and probably an equal or even greater amount is put into the crib with a hand shovel. When we look at the matter from this angle, it is quite apparent that the present equipment for handling our most important crop is still far from adequate, either mechanically or economically or both.

The reason mechanical pickers have not been used more generally can probably be attributed partly to the cost of such equipment and partly to the loss of corn in its use. Dr. J. B. Davidson of Iowa State College recently stated that in their tests of corn pickers this year the losses of corn were less than with hand picking for the first time in their experience. This indicates that the picker has been undergoing considerable improvement. But it is also plain that there is room for more, and it seems probable, until corn pickers are developed to a point where they reduce this loss of grain to a minimum and at the same time are simplified so as to place them within the economic reach of the average corn grower, at least through the corn belt, the engineer has by no means completed his job on this machine.

While efforts to use the cornstalks for commercial purposes such as the production of paper, wallboard, etc., also date back about twenty years, only an infinitesimal part of the corn fodder is today being used for such purposes, and much of it is still being burned instead of being utilized for the production of humus, apparently because present equipment for incorporating the stalks with the soil are inadequate.

Just what the future holds in the way of industrial uses for corn fodder, no one would dare to predict. This probably will depend largely upon research work by chemists, such as is now being carried on at the USDA Northern Regional Research Laboratory under the direction of Dr. E. C. Lathrop. However, sufficient progress is being made along this line to indicate that the agricultural engineer had better get into high gear in producing equipment which will permit harvesting corn fodder at low cost and without too much contamination with soil.

There seems to be at least a possibility of utilizing corn fodder through the corn belt states for the production of wallboard or some similar building material which will compete favorably with lumber and with insulating board made from bagasse or other wastes located at considerable distances from the corn belt. The saving in the cost of transportation gives promise of making such a development economically practicable.

If we do not use the corn fodder for some such purpose, we shall soon be compelled to find some additional means of controlling the European corn borer. Whether the entomologists solve this problem or whether the agricultural engineer will come through with the solution remains to be seen. Professor R. H. Wileman of Purdue University has been hot on the trail and may have part of the answer in his pulverizing attachment for the corn picker.

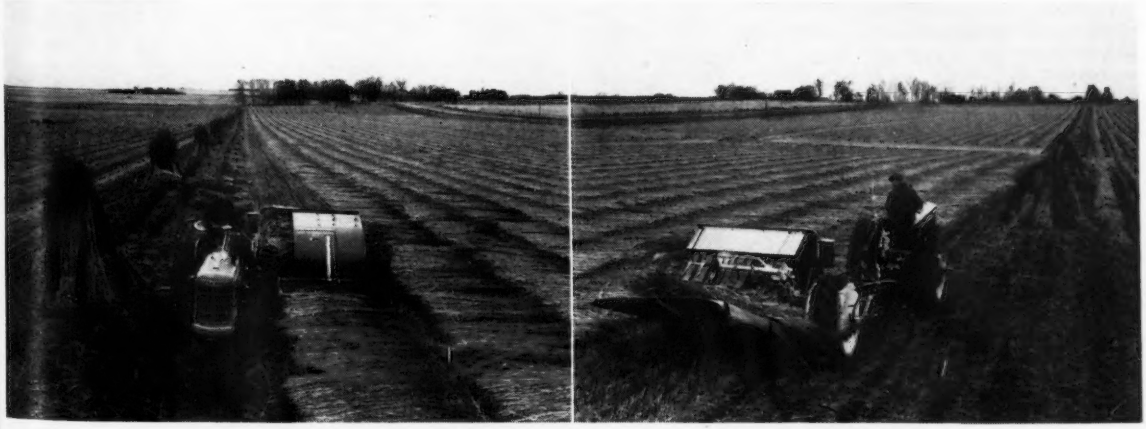
It is no secret that several implement manufacturers have developed machines which not only snap and husk the ear but shell the corn and deliver it into a wagon or truck. The use of such equipment would eliminate the operation of corn shelling on many farms and effect a saving in labor and cost in the production of the corn crop.

The only reason such equipment has not been sold in quantity is on account of the problem of storing field-shelled corn with its relatively high moisture content. This puts up to the agricultural engineer the problem of developing a farm drier or some means of safe storage and drying of such corn either by natural or artificial ventilation and perhaps the application of heat.

A great deal of research work has been carried on along this line and considerable progress has been made, but we still await proof that the problem is solved and the necessary equipment available.

Papers presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1943. A contribution of the Power and Machinery Division.

ARNOLD P. YERKES is in charge of farm practice research, International Harvester Company.



Gathering hemp with a new gatherer binder. (Photo by courtesy of International Harvester Co.)

On the basis of acreage, that part of our corn crop harvested for silage seems rather insignificant — only about 5 per cent of the total corn acreage. But when we make the comparison on the basis of weight it presents a different picture. The average weight of corn harvested per acre is only a little over a ton, while the average weight of silage corn is about eight tons per acre. About 35,000,000 tons of corn go into silos each year, or about 40 per cent as much tonnage as all the corn harvested as grain.

Most of this silage corn is loaded onto wagons by hand and unloaded by the same laborious method. This is in spite of the fact that machinery has been on the market for years which is capable of chopping and loading the corn onto wagons or trucks at one operation, from which it can be dumped into blowers with a minimum of hand labor.

Obviously, such equipment has not fully met the requirements of the situation and further development is needed before we can truthfully say that the production of silage is really mechanized.

Next to corn, hay is our most important crop so far as acreage and tonnage are concerned. For this crop too there is machinery available which permits placing it in the barn, stack, bale, or steel bin without any lifting or handling by human muscles. Yet very few pounds of hay, relatively, ever go into storage without having exacted a toll of "elbow grease." Worse than that, every year sees hundreds of thousands of tons spoiled in the field or in storage — probably the greatest loss on the average for any crop.

To this enormous loss by spoilage we must add another loss which, if the facts were known, would probably approximate if not surpass the spoilage — that is the shattering of the leaves, the most nutritious part of the hay.

Making the grass into silage instead of hay is a partial solution, and machinery is available to do this with a minimum of hand labor, but there is still considerable question as to how large a percentage of the grass acreage can be satisfactorily handled by this method. Until improved methods and/or equipment are devised that reduce the present expenditure of man labor, spoilage, and waste in the handling of our hay crop, there is obviously a great need for further development.

There is also room for the development of methods and equipment that will take some of the hand labor out of the job of distributing loose hay in mows and in piling bales in storage. Mowing hay is a hard, hot job that practically every farm worker thoroughly detests. The removal of hay or silage for feeding and the distribution to the animals are in about the same class, and here too some new developments are highly desirable.

NEW CROPS PRESENT NEW REQUIREMENTS

Whenever a new crop becomes popular or an old one is grown more extensively, there is likely to be a need for some new developments or modifications of farm machinery. Examples are castor beans and sweet potatoes.

For the past few years, the increased need for castor oil for war purposes and as a substitute for tung oil indicated that the castor bean might become a permanent and important crop in our agriculture. Improvement in shipping conditions from South America has changed this picture somewhat, for Brazil has large quantities of castor beans and cheap labor to handle them. Whether we can compete with them in peacetimes is open to question, but no less an authority than Dr. W. L. Burlison, head of the agronomy department at the University of Illinois, believes there is a good possibility that we can, at least to some extent. They have yielded well on some land so poor that no other crop would grow.

They can be combined fairly successfully after they have been frosted, but with many varieties the earlier spikes shatter badly before this. Unless non-shattering and evenly ripening varieties are discovered or developed, it seems doubtful if they will be widely grown until a harvester is developed that will gather the ripe beans without damage to the stalks, leaves, and green spikes.

The sweet potato has been suggested as a crop that might supply the South with a cheap source of carbohydrates which it needs badly. For a time it was hoped that sweet potato "strings" might be cut into pieces and planted in much the same manner as white potatoes, thus eliminating the labor and expense of growing plants in beds and transplanting them. It is reported that the results of experiments have not been as good as has been hoped, but if it does prove practicable a planter will be needed that will plant the "strings" satisfactorily. Also, if they are to be grown on a large scale, a different type of digger will be required. Equipment to harvest the vines for feed or silage, or at least remove them before digging, will also be in demand. This and similar crops may furnish a fertile field for new developments.

Summarizing, it seems safe to say that practically all of our present equipment needs further development before the bulk of our staple crops are really grown and handled with machinery, and there is still a large number of new machines to be developed. The job is far from finished.

Paper by Eugene G. McKibben

FELLOW A.S.A.E.

NO CLAIM is made that all or even any of the needed farm machine developments mentioned in this paper represent new ideas. In fact, the solution of some of the problems proposed may even have reached the production stage in some manufacturer's postwar planning program and be waiting only the lifting of certain wartime restrictions.

Neither is any claim made that the list is complete. After two years of wartime food production effort with limited equipment and labor, any farmer can suggest several additional items. Attention should also be called to two reports on research in mechanical farm equipment, namely, by J. B. Davidson[1], published in 1926, and by H. B. Walker[2], published in 1928.

Further, no attempt will be made in this paper to propose solutions for the problems presented.

Machines for Irregular Fields and Contours. A complete line of field machines which would operate in their own path and turn in their own length would solve most of the machine problems resulting from small irregular fields and such soil conservation practices as contour farming and strip cropping. Such machines will be increasingly needed as the mechanization of agriculture is pushed into less favorable areas and soil conservation practices gain wider acceptance.

Orchard Mowers. College professors and farmers are not reasonable. Not only do we want a complete line of machines which will operate in their own path, but in some cases machines which will operate both in their own path and to the side are demanded. I have in my files a request from a fruit growers' association for a tractor mower that will mow to the side under the low hanging limbs of trees and also mow the narrow strip between the ends of the limbs of adjacent rows of large trees. If anyone has a machine to solve this one, ready for production, I want the name and address.

Tractor Chassis for "Self-Propelled Machines". In connection with the problem of mounted machines, perhaps the functions of the farm tractor should be carefully reanalyzed. Possibly it is time for the introduction of a tractor which instead of being a draft machine would be primarily a chassis for mounting such harvesting machines as balers, forage harvesters, combines, and various types of corn harvesting equipment.

Minor Tractor Developments. A minor but important tractor development needed is an independent friction clutch for the power take-off. Also, if these tractors are to be safe for returned jeep drivers, truly equalized brakes will be required.

Reliable Small Gasoline Engines. While power units are being discussed, the need for lighter, more reliable small gasoline engines should not be overlooked. The reliability of the electric motor furnishes a suitable goal. Because most of the troubles with a gasoline engine are starting troubles and because most of the starting troubles are either not enough or too much fuel, it is time for some one to develop an accurate, low cost method of indicating whether the mixture in the cylinder of a balky engine is too rich or too lean.

Mounted Machines. Further progress is needed in the case of attaching and removing mounted machines. In particular, such machines should be removed in the minimum number of pieces with absolutely no small detached parts to be lost between seasons.

Mulch Culture for Humid Regions. In the field of tillage and cultivation, current studies of the mulch culture program in the

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[1]J. B. Davidson, Research in Mechanical Farm Equipment, Bureau of Public Roads, U. S. Department of Agriculture, December, 1926.

[2]H. B. Walker, Research in Mechanical Farm Equipment, Miscellaneous Publication No. 38, U. S. Department of Agriculture, December, 1928.

Raking hay in Arkansas with Case tractor and side-delivery rake. (Photo by courtesy of Firestone Photographic Service)

more humid sections indicate the need of equipment to give better weed control. Otherwise such areas will not be able to enjoy the advantages which may be inherent in this system of culture.

Rust-Resistant Tillage Tools. In view of the great advances made in metallurgy, it should certainly be possible to produce stainless — that is, corrosion-resistant — tillage elements, such as plow bottoms, cultivator shovels, etc., which would also scour satisfactorily. The recent developments in rust-preventive coatings are a real advance, but they represent a makeshift and not a real solution. If we really wish to keep tillage elements from rusting, it may be easier to change the character of the tillage tool than of the farmer.

Precision Planting. Precision planting equipment is needed for sugar beets. Precision is of course a relative matter. In this case I have in mind a planter which will place a single seed within one-half inch in either direction from the ideal location in the row. If such equipment were developed for beets, there would undoubtedly be many additional uses found. This sounds easy to one who has not tried it. Perhaps it is an easily solved problem. If so, let's have the solution, because many think that this is the point at which successful mechanization of sugar beet production must start.

Supplementary Irrigation. In many areas, particularly in the lake states on sandy soils, there is a real opportunity for the development of coordinated equipment for supplementary irrigation of the spray nozzle type such as is used on golf courses. One or more companies might well consider the development of complete systems, including tractor, pump, portable pipe, nozzles, and engineering service. At present the farmer has to assemble these elements from widely scattered sources.

Power Pruning. One of our Michigan county agricultural agents has suggested the need of a power-operated pruning shears or saw. It appears to be a reasonable suggestion. In round figures there are well over three million acres of orchards, groves, and vineyards in the United States. Three million acres of pruning represents a lot of strong arm work.

Beet and Potato Harvesters. There is real need for some development which will separate potatoes or topped sugar beets from stones and clods. For years this mere minor detail has stood in the way of the complete mechanization of potato and sugar beet harvesting.

Cornstalk Bedding. Livestock states like Michigan need more bedding. This is particularly true now that the combine has attained wide acceptance. Proof is supplied by the fact that during recent years baled straw often sells for as much or even more than good alfalfa hay. Chopped cornstalks are excellent bedding. There is real need for the development of equipment which will put corn in the crib or bin and dry chopped cornstalks in the mow without excessive labor. For many, if not all corn-producing areas, this is a more important problem than the harvesting of cornstalks for industrial use.

Manure Loaders. While we are talking about bedding it may be well to note that something more convenient and more universally adaptable is needed for loading the manure spreader. The U. S. Department of Agriculture estimates that there are more than one million manure spreaders on American farms. Thus there would be a real market for a manure loader that would actually meet the needs of the average owner of a manure spreader.

Conveying and Elevating Equipment. The possibilities of using conveying and elevating equipment in crop storage and livestock buildings has not been given sufficient consideration. This is particularly true since many of our farms have obtained high-line electric service. Figures from the Edison Electric Institute indicate that over 40 per cent or nearly 2½ million of the nation's farms are on high lines. Approximately two-thirds of this electrification has taken place since 1930 and most of us still do not realize the possibilities offered by electric motors on these 2½ million farms.

Once-a-season Lubrication. Last but not least we need once-a-season lubrication for important farm machines. Consider a two-row corn picker, as an example. Some of these machines have over 100 grease-gun connections. I worked with a beet harvester this fall which was just as bad. The proper lubrication of such a machine takes about ten per cent of the operator's time. Thus the elimination of the necessity of hour-to-hour and day-to-day lubrication would add over 10 per cent to the capacity of the outfit.

Admittedly this is a difficult if not a crazy proposal. The advantage involved, however, is of real importance. A corn picker which had to be lubricated only once a season should be worth at least ten per cent or $60 to $80 more. The saving of one hour per day of the operator's time at 50 cents per hour for 10 days would be $5 per year. The total benefits appear still more important when we consider that if half the nation's corn crop is harvested mechanically between three and four hundred thousand machines will be used.

In any event, I believe that, if each member of this audience was sentenced to operate a corn picker each fall for 10 years, before the end of the term of service we would have a satisfactory solution of the problem of lubricating complicated harvesting machines.

Paper by Elmer J. Baker, Jr.

MEMBER A.S.A.E.

THE bald title of this discussion carries the assumption that the tractor designers, some of whom may also be engineers, have left undone those things they should have done, and, possessing idle hands, have done those things they should not have done. I endorse that assumption.

Some 10 or 12 years ago, tractor designs largely froze as the result of the prior freeze of designing imagination. There was the Farmall — and everyone knew how it sold — so any departure from its basic design was flying to the poorhouse on a lighted course with no excuse for getting off the beam. Any tricycle-type model which could perform as well as or better than the Farmall would sell and produce profits out of all proportion to the engineering originality embodied in such a tractor. Chief designers therefore became classed as bigshots and were paid accordingly. They lost the basic urge to go forth in hot summers and hop clods in dusty fields, out of which experiences new ideas occasionally blossom. Instead they hired assistants to do the dirty work.

These men of less economic security could not return from the clodhopping imposed on them and tell the bigshot engineer that his brainchild was already verging on obsolescence. Such a report would insure no more clodhopping but a direct return to the drafting board. So the assistants concentrated on cost reduction — a nickel here and dime there. Each nickel saved would pay for another $5,000 engineer in the course of a year's production, and when hired he in turn would shave off another nickel.

What had occurred to bring on this obsolescent phase? It was the parasite machine designed to function solely on the one host tractor (never on a competitive model), said parasite machine weighing anything from 1 to 3 tons, and mounted perforce so that a distressingly large proportion of the weight was imposed on one measly spindle carried on one unsuspecting Timken and rolling on two baby-buggy wheels with a flotation factor under frequently encountered soil conditions not much greater than that of a canoe.

Now I know enough about Bert Benjamin's mental processes to be sure that he never envisioned the original Farmall carrying a two-row mounted picker. He was designing an all purpose tractor to carry cultivators and planters, not Behemoth machines requiring three cranes, ten men and two weeks to put the many bundled provocation from where it was, roosting on the ground, to where it had to be, teetering insecurely on top an inherently unstable

ELMER J. BAKER, JR. is editor, Farm Implement News.

triangulated carrying medium whenever such a parasite became affixed to its host. Even when it was possible for the hybrid combination to operate according to plan under favorable field conditions, it could not cut square corners, which should be done if either crops or time are not to be wasted.

It remained for the open-minded independent engineers, such as those who designed the Hume-Love mounted field-pea windrower, and for the oppressed engineers on whom was laid the onus of bailing out some millions' investment in cotton picking machines, to devise the perfectly obvious way to run a tractor and to carry a heavy machine in the field and be able to turn square corners. And that is to run the tractor backwards in order to follow a straightforward path. In doing this, one had a husky rear axle member to carry most of the superimposed load instead of that pathetic steering mechanism at the other end.

It is a matter of gratification to me that the penumbra of mental obfuscation in tractor designing circles is beginning to brighten as indicated by certain recent patents on tractor transmissions which permit the machines in which they are ultimately to be installed to operate with six speeds backwards with all the alacrity they now do forwards. And I hardly would believe that the designers responsible would go through all that mental travail and not figure out some means of reversing the tractor seat and having the controls handy for either direction.

There is even a hope — a very faint one I admit — that the brains which can release a tractor from one-way progression may also be able to envision field caster-mounted machines which can be pushed like a river barge and attached merely by bumping with a railway coupler, plus the tightening of two nuts on bracing members and one clamp on the power take-off. But that's enough for you tractor fellows. Now we've got to get political.

I am worried about the Planners, whose strivings and objectives I have so long notoriously admired. I'm beginning to waver in my faith. These Planners are talking about effectuating a stabilized 130-billion dollar national income in the postwar period so that we can pay off the cost of the war, prepare for the next one, and obliterate poverty, distress, and malnutrition wherever our glorious flag waves — island possessions excepted. We may still wish to produce sugar cane cheap.

Now it is impossible to banish malnutrition by circulating more hard and folding money in rural regions. Malnutrition is a matter not only of quantity of food but of kind of food. In one generation and a little more, we have utterly changed our eating habits. We have pushed bread, the staff of life, to the position of an entree — something out of which to make a thin slice of toast for a symbolic breakfast. We no longer feed salt pork and beef even to shellback sailors on the high seas. Women flee in terror at the sight of a baked potato.

What we have substituted is a diet largely made up of watery vegetables, fruits, meat and dairy products. The government thinks we can even do without much meat if we only raise big enough victory gardens. I haven't taken the trouble to look up the figures because I am not concerned with split digits, but I read not long ago that the acreage in onions was some ten times what it was when my youthful diet was chosen by parents who never had heard of a vitamin and whose ideas of a salad were some "greens" in the spring when you could get them for nothing at the market, like liver for the cat.

During this period when we have abandoned sow belly and corn pone for salads and fruits, we raised a new generation which today is largely swallowed up in the armed services. I cannot put my finger on the quotation, but not long ago there was an item stating that the boys going through the medical centers prior to enlistment and induction are 3 inches taller than their fathers of the first World War and 20 pounds heavier. This new diet of ours is producing a race of supermen and women. It would seem worth perpetuating.

It never will be if the Planners are able to impose a 130-billion national income, because these succulent vegetables and fruits are produced by drudge labor paid, not subsistence wages, but eke-out wages. We must have impoverished families and underpaid field hands if we are to maintain our superman diet.

These hand crops are raised by truck and fruit growers who perforce must go to the "slave market" — that's what they call it — and bring back for a long day's work groups of women and children who work stooped over in the field all day for a pittance, and they do it with fewer "quits" than our shipyards and plane producers have. These industrious and uncomplaining field workers produced our superman diet. They worked for meager wages to help out the working father whose driving ambition has been to give his children the opportunities denied those in the old country. We won't have such workers with a 130-billion annual income, and the Planners are hell bent on that objective.

Maybe our engineers and designers should lower their proud gaze to the humble fields where truck and fruit are raised. There is an absolute void of labor-saving equipment for many essential operations with most of these crops.

If with the help of the plant breeder we cannot produce a commercial tomato harvester, we may not have much tomato juice in the future of a Planners' world. This year our normal 8-million-bushel pickle crop dropped 2 million bushels.

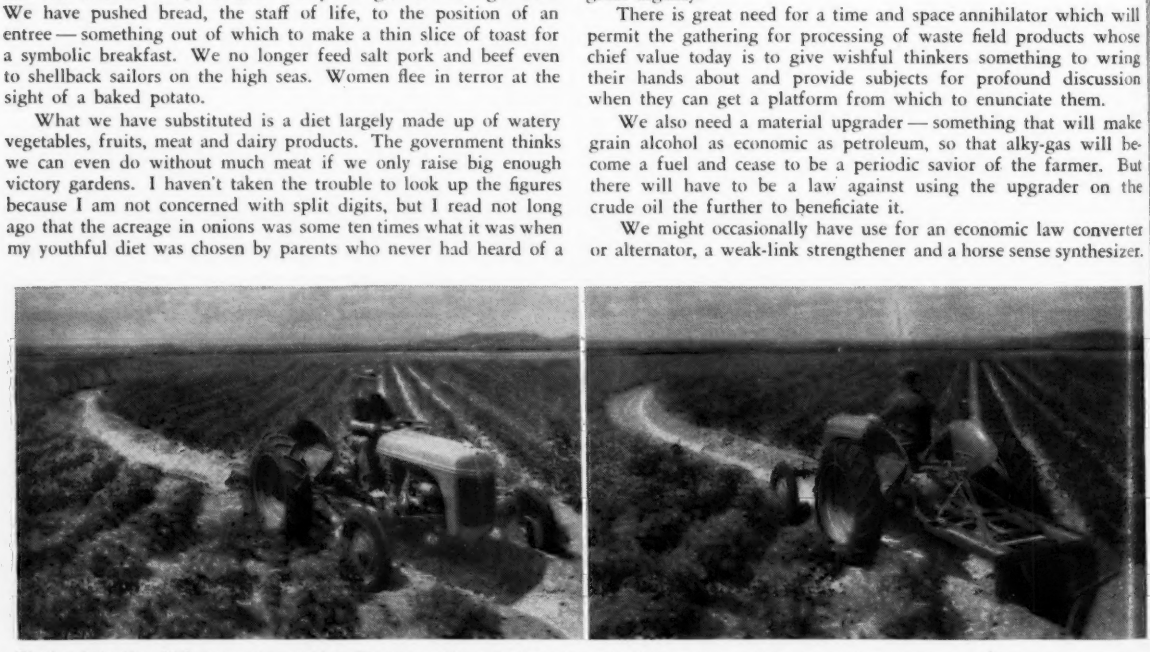
Long years ago we mechanized the wheat crop. Corn came under control when the New Idea picker was developed. Deere, it is said, has licked the sugar beet harvest problem. And Harvester with its new cotton picker may alter the whole world textile fabric. The need now is for mechanization of those crops which so profoundly affect the health and well-being of the people of this country.

In conclusion I shall indicate a few other specific needs of great urgency.

There is great need for a time and space annihilator which will permit the gathering for processing of waste field products whose chief value today is to give wishful thinkers something to wring their hands about and provide subjects for profound discussion when they can get a platform from which to enunciate them.

We also need a material upgrader — something that will make grain alcohol as economic as petroleum, so that alky-gas will become a fuel and cease to be a periodic savior of the farmer. But there will have to be a law against using the upgrader on the crude oil the further to beneficiate it.

We might occasionally have use for an economic law converter or alternator, a weak-link strengthener and a horse sense synthesizer.



Digging irrigation ditch in a potato field in Nebraska with a Ford tractor and ditch cleaner. (Photo by courtesy of Firestone Photographic Service)

The Water Facilities Program in the War Effort

By Howard F. McColly
MEMBER A.S.A.E.

THE western United States beyond the 100th meridian is a dry country — arid and semiarid — except for the humid corner of the Pacific Northwest and those favored mountain slopes upon which the clouds spill their moisture. Even these so-called humid areas will make use of irrigation water, if it is economically possible to furnish it, to care for those drought periods when the clouds do not "spill".

There are 740 million acres of land in the West which includes some of the most fertile soils on the continent — soils that have the potential of producing immense quantities of wartime foods and fibers. Out of this vast area 21 million acres of land are irrigated by all types of irrigation enterprises. Under present standards of economic feasibility it is estimated by irrigation authorities that an additional 20 million acres can be irrigated with water resources yet undeveloped. The 21 million acres of irrigated land in the West represents about 3 per cent of the total area, or 11 per cent of the cropland, and these irrigated lands produce 30 per cent of the crop income.

In peacetime the West supported 14 million people and in the present emergency it is most fortunate that it had this population. Without irrigation the population would have been much less, and the wartime activity on the Pacific Coast would have been different than it is. The food produced in the West and the population in place has reduced the strain on an overburdened transportation system that is needed to move troops, materiel, and supplies. Irrigation projects aid in the food problem; thus all irrigation and water development works that have been constructed and are in the process of being built contribute directly to the war effort.

In the West the word farming is supplemented with such terms as "dry farming", "ranching", and "irrigation". Dry farming, which is farming without irrigation, is a precarious operation. Rainfall hovers around the minimum with which it is possible to produce crops and too frequently it is less than that minimum. The development of an irrigation water supply to supplement rainfall, or to irrigate a small feed-base plot, tides a dry-land operator over the dry years and enables him to retain his livestock.

Ranching involves principally livestock production with little or no soil tillage. Livestock is grazed on the range, usually vast in extent, feeding on the natural grasses produced by the scant rains. Range livestock water for a ranching enterprise is necessary and where not available in natural sources has to be developed. Ranches do not remain in existence where water cannot be obtained within reasonable distances. Many ranches develop irrigation of meadows, alfalfa, or small feed-crop tracts. The livestock industry, founded on ranching, is one of the most important in the West. Thus there is a direct complementary relationship between ranching and irrigation agriculture in the West.

A general cultivated agriculture in the arid and semiarid sections requires irrigation. It is the only means providing for the close settlement of rural areas. It supplies the necessary complementary feed for the livestock industry thus aiding in the production of dairy products, eggs, meat, leather, wool, fats, and many other wartime necessities. It enables the production of much needed crops — dry beans, peas, sugar beets, potatoes, guayule, vegetables, fruits, and many others. Irrigated land can quickly shift to the production of those needed crops that are determined necessary in emergency.

The water facilities program of the U. S. Department of Agriculture is in operation in the arid and semiarid areas of the western states — those 17 states bisected by or lying west of the 100th meridian. During the past several years the federal government has made funds available to help western farmers and ranchers make better use of their water resources. For the 12 months from July 1, 1943, to June 30, 1944, Congress appropriated $1,000,000 to carry out the provisions of the Water Facilities Act (approved by the President on August 28, 1937, and amended October 14, 1940) which provides for assistance to farmers in developing and utilizing water for farms and ranches. The Farm Security Administration administers the water facilities program and the benefits of the program are extended only to bona fide farm and ranch operators whose lands are actually used for agricultural or grazing purposes, or would be placed in such use as the result of a water facilities development. The farmers take the responsibility for getting the job done. They receive the loan money, pay for the materials and equipment when the work is done directly, or pay the contractor on a contract job. Representatives of the Farm Security Administration give supervision, technical guidance, and engineering service as needed.

The program includes only those types of water facilities which make it possible for farmers and ranchers to store or utilize water for livestock, crop and hay lands, ranges and pastures, farm gardens, domestic water, and other agricultural purposes. Assistance is offered in constructing, installing, repairing, and keeping in use the following kinds of facilities: (1) Ponds and reservoirs; (2) stock water tanks and dugouts; (3) spring developments; (4) wells and pump and windmill installations; (5) facilities for recharging underground reservoirs; (6) farmstead water and farm garden irrigation; (7) detention, retention and diversion dams; (8) water spreaders, and (9) conduits, irrigation facilities, and farm distribution systems.

In addition, loans may be made for the purchase of water stock in companies or associations if the transfer of the water right will result in better water-land use. For example, the transfer of the water right may help prevent the wastage or inadequate use of water resources, or make it possible to use water on good instead of poor land.

Farmstead water means the provision of water for livestock use near farm buildings, water for use in farm buildings, water for the irrigation of gardens of one acre or less, but does not include plumbing or plumbing fixtures within farm buildings. However, under the program domestic water is made available to the farm family. The providing of wholesome water for thousands of farm families is important, especially so during the present emergency. Thousands of western farm families obtain their domestic water supply from irrigation ditches, ponds, streams, polluted wells, and other impure sources. The prevention of disease keeps these farm families on the food production front and decreases the calls on overburdened doctors and health officials.

The irrigation of a small farm garden often is all the irrigation water that a farm can develop. The importance of these many farm gardens cannot be ignored. Their contribution to the food stocks, the saving of transportation facilities, the saving of commercial processing

A typical irrigated valley in the western United States developed from former desert lands, now the mainstay of western agriculture, industry, and commerce. (Photo Courtesy of Farm Security Administration)

Paper presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1943. A contribution of the Soil and Water Division.

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labor, and the enjoyment of better farm family health are definite tangible results.

The Water Facilities Act is intended to provide for a great number of *small* water facilities. It is estimated that more than 90 per cent of the facilities constructed under the program cost less than $2,000. The Act, as amended, sets $50,000 as the largest amount of federal funds that can be made available for any one project.

Funds are to be used to provide carefully planned water facilities in order to make the wisest use of land and water resources over a period of years. Before work is started careful consideration is given to all factors which may affect any proposed development within a watershed or an area as a whole and on a case by case basis. The conservation programs branch of the War Food Administration takes the leadership in making general plans for water facilities benefits and its technicians are assigned to assist. Local farmers and agricultural technicians in the area also assist in developing the over-all plans. Careful planning will promote the wisest use of land and water resources for the enduring benefit of the people on the land and enable them to enjoy a better living and fuller opportunities. A substantial contribution is thus made to the nation's welfare, both in wartime and peacetime. Wise planning does not encourage plowing up areas that should not be plowed — a condition that arises too often when high farm prices tend to expand the production of food and fiber products.

The farmer or rancher who benefits from the building of water facilities is required to pay as much of the cost as his circumstances will permit. A determination is made with him of the contribution he can make in terms of material, labor, equipment, and other items. Farmers who are financially able to construct or repair water facilities and only need technical assistance in planning and laying out their projects may obtain these services in areas where personnel is available.

WATER FACILITIES TO BENEFIT PRIVATE LANDS

Western farmers and ranchers who cannot obtain adequate credit from other sources are eligible for water facilities assistance this year. Loans are made at 3 per cent interest and repayments may be spread over a period equal to the estimated life of the facility or over a period of 20 years, whichever is the shorter time. Borrowers are not expected to repay the government for the engineering, legal, soil conservation, farm management, and other technical services they receive, nor for the loan processing and collection services.

Water facilities will be built only to benefit privately owned lands. They will not be installed on public lands, except where such improvements are necessary to provide a suitable water supply for the benefit of farm families living on nearby or interspersed non-public lands.

A tenant farmer may take part in the program if he can meet two requirements: (1) He must provide satisfactory security for the loan, and (2) he must have a satisfactory lease which will enable him to bear his share of the cost on constructing the facility.

Often farmers living near each other find it desirable as well as economical to construct or repair a facility that a group of them can use jointly. Operations for group use may be handled by organizing the group into a cooperative association, a mutual water company, an irrigation district, a soil conservation district, or similar organization. Facilities that adapt themselves to group operation are irrigation projects and rural water supply where farmers live in close proximity.

In order to make the best possible use of the farmer's land and water resources and his family farm labor, every farmer obtaining a water facilities loan follows his individual farm management plan carefully worked out. Greater security and better family living are the result since the farm management plan provides for (1) efficient use of water, land, and farm labor, (2) a production schedule including farm and home expenses and loan repayments, (3) enough food for the family and enough feed for the livestock, and (4) the proper operation and maintenance of the facility which has been constructed.

The chief emphasis in the program this year is directed toward the repair and maintenance of those water facilities already in existence. Many of these facilities were built years ago by various public and private groups and are on the verge of breakdown; in fact, in some instances they have become broken down before assistance is sought. Deferred or neglected maintenance accounts for much of the run-down condition of many facilities. On some projects it has not been recognized that trouble was slowly accumulating. Canals have become so loaded with silt or heavily choked with brush and weeds that the water delivered to the farms gradually becomes less and less until the crops suffer and the farmers realize that the canal should be cleaned out. Structures slowly decay or crumble and earth erodes from around them, all unnoticed until the water gets away or a load of hay breaks through a crossing. Pumping plants, wells, and windmills wear out and sometimes springs need cleaning out or new pipe lines installed. Erosion weakens canal banks and earth fills causing eventual failure which could be prevented by proper control measures or replacing fill material as necessary. Existing facilities are subject to damage by storms, floods, and other causes beyond human control. Storage and diversion dams, flumes, and inverted siphons are sometimes damaged and have to be repaired or even entirely rebuilt. Earth and rock slides and wind storms may damage installations requiring renovation and even replacement to make it possible for the farmer again to produce food.

Wherever possible aid is given to sustain a facility in productive use by repairing failures and having maintenance work done that will render the facility more useful and efficient. The farmers are on the land and the problems inherent in the development and settlement of new areas are avoided. These farmers have buildings and farm machinery, and the land has already been prepared for irrigation. A minimum of war-critical materials are required to maintain production on these farms. Another factor that results from the renovation of a facility is that the capacity or efficiency is increased and more land can be placed in production, higher crop yields obtained, and the livestock industry expanded.

Where they will make a substantial contribution to increased food production in 1944 and 1945, new water facilities are being installed. In most cases entire areas have been designated for operations. For example, the Southern High Plains of Texas, an area of approximately 20,000 square miles centering around Plainview, through the assistance of the program this year will add approximately 15,000 acres to the production role. This will mean 150 irrigation-well installations, each one serving 100 acres of irrigated land. The major crop will be grain sorghum which is used for livestock feed. The Platte River Valley in Nebraska, where vast water resources are available through irrigation wells, is another area where large-scale operations are under way. Irrigation-well areas in Colorado, California, and Idaho will also make large contributions to the food and fiber production schedule.

THOUSANDS OF FARM FAMILIES ARE BENEFITED

Since the program was begun five years ago more than 9,500 farm families in the West have been benefited, either individually or through associations. More than 12,500 water facilities of all types benefiting more than 3,600,000 acres of land have been completed or are under construction. This includes livestock and domestic water developments and irrigation benefits. The irrigation benefits have been extended to over 146,000 acres. In addition, considerable basic information has been obtained about desirable developments in 264 watershed areas involving 427,625 square miles.

The loan funds obligated for water facilities projects from the beginning of the program through June 30, 1943, has reached a total of $3,495,592. Repayments on these loans on June 30, 1943, were equal to 98.2 per cent of the total amount matured. This is definite proof that water facilities are a good investment.

The value of the program cannot be measured in dollars and cents alone within the program. The pay-off in benefits reaches into so many channels it is forgotten that the water development was responsible for the many benefits. The production of food and livestock is stabilized and often increased, thus resulting in permanent, self-sustaining communities as well as offering new opportunities to families seeking new frontiers. On the western farm a more full utilization of the farm family labor and a rounding out of the farm management program mean a better and healthier farm life. These factors make a strong, balanced, contented nation. By providing carefully planned water developments in the West, our resources — land, water, and people — are utilized for the economic welfare of the nation.

Interchangeable Power Units for Farm Machines

By F. W. Duffee
FELLOW A.S.A.E.

THE trend toward using mechanical power on American farms has been upward for over one-third of a century and very markedly so for the last quarter century. As we look back over the history of this development, we can see that it has not been a steady and uniform trend, but rather a series of periodic expansions due to certain highly important technical developments that have broadened the usefulness of the tractor. I refer to farmer use of tractors rather than yearly sales or total tractor inventory. A few of the more important developments are (1) the light-weight, unit-construction tractor about 1920, (2) the power take-off about 1921, (3) the row-crop cultivating tractor in 1923, (4) the adoption of pneumatic rubber tires and higher speeds in 1932, (5) the small one-plow tractor in the late thirties, and (6) while probably of less importance, the addition of the self-starter.

Paralleling these tractor developments are a few outstanding developments in tractor-operated machines, the more important of which in this area appear to be (1) power-take-off-driven machines, (2) redevelopment of the power-take-off-driven corn picker, (3) the windrow baler in the late twenties and early thirties, (4) the small light-weight combine in 1935, and (5) the forage harvester in the late thirties.

I don't want to minimize for one minute the hundreds of small developments and improvements that have brought tractors and tractor-operated machinery to their present stage of efficiency, but the above outstanding developments are epoch-making in my opinion.

The use of mechanical power is expanding horizontally as well as vertically; that is, we not only use more mechanical power but we use this power for more jobs.

An analysis of these developments shows an important trend, the application of considerable amounts of power directly to the machine, either through the power take-off or with an auxiliary engine mounted upon the machine—for example, the combine, the windrow baler, and the forage harvester.

Also the increasing inventory of tractors on farms has resulted in a vastly increased inventory of belt-driven machines such as the ensilage cutter and the feed grinder.

Most of the windrow balers are regularly equipped with auxiliary engines.

The popular 5 and 6-ft combines for the most part are power-take-off-operated, but in Wisconsin and I assume in other similar areas the trend is setting in very strongly in favor of auxiliary engines. Data which I have indicates that fully 15 per cent of the 5 and 6-ft combines sold in Wisconsin in 1941 were equipped with auxiliary engines. While a year or two before a negligible percentage were so equipped.

It is almost the universal opinion of implement company representatives that in a few years at least 50 per cent of the 5-ft and larger combines sold in Wisconsin will be equipped with engines, or at least this percentage of buyers will much prefer engines.

Forage harvesters and field ensilage harvesters require considerable power and frequently tax the ability of a two-plow tractor, especially where the wagon is pulled behind the machine. These machines, however, are not as critical in their power requirements as combines because there is not the need for uniform machine speed and uniform feeding to secure good results as is the case with combines.

Many farmers now put up corn silage with very small crews, either with just their own farm help, or in the case of one-man farms two or three farmers work together. There is frequently only one tractor available, and this must be used to drive the ensilage cutter, whereas a great many would like to pull the corn binder with the tractor if they had other power for the cutter. The auxiliary engine used on the combine or baler provides a most satisfactory source of this power, especially if the cutter frame is modified so that the engine can be mounted on the cutter.

When putting up grass silage, hay, combined straw, or corn silage with the forage harvester, at least two power units are almost absolutely necessary, that is, a tractor on the harvester and a tractor or engine on the blower. The combine engine again can supply satisfactory low cost power for the blower.

Summarizing up to this point then we find these facts:

1 The power take-off drive is not entirely satisfactory for some field machines, particularly under adverse conditions.
2 A considerable number of machines are now equipped with auxiliary engines.
3 A large inventory of belt-driven machines.
4 An increasing number of machines that can profitably be equipped with auxiliary engines.
5 An increasing popular demand for auxiliary engines on combines and some other field machines.

So we find an increasing demand for strictly engine power, either on field machines or for belt work.

The question might be asked, why wear out the engine of a $1,000 tractor to do belt work when a $300 engine will do the job?

The only real advantage of the tractor for belt work is the convenience of being self-propelled. However, we know from actual experience that an engine mounted on the ensilage cutter is far handier than is a tractor-operated cutter.

Machines that can conveniently be operated by an engine, either as an auxiliary power unit on the machine or as a belt power unit, are the (1) combine, (2) forage harvester, (3) field baler, (4) field corn ensilage harvester, (5) two-row pull type corn picker (possibly), (6) stationary ensilage cutter, (7) crop blower, (8) feed grinder, (9) woodsaw, (10) irrigation pumps, and (11) grain and corn elevators.

Obviously not all of these machines would be used on any ordinary farm, but at least three or four of them will be found on most tractor-operated farms now, and as has been pointed out previously the applications are increasing.

The advantages of mounting an auxiliary engine on a small combine must be considerable to warrant the added investment. However, if this same engine can be quickly and easily removed and transferred to a baler, or used for grinding feed and operating an ensilage cutter, then it may become very economical power indeed, and the advantages of the auxiliary engine for field machines can be had at very low cost.

To be able to make these changes easily, however, will require some standardization of machine mountings. This standardization can be developed easily so that any conventional engine can be equipped with mounting brackets and a standardized power coupling for quick attachment. All that should be necessary to adapt any engine to any machine would be a few simple mounting brackets.

A farmer may buy one make of combine this year and another make of hay baler next year. He should be able to use the engine of his combine on his baler, and vice versa.

So far as standardizing mountings is concerned, the situation is almost ideal now *(Continued on page 47)*

The combine heads the list of farm machines that can be conveniently operated by an engine, either as an auxiliary power unit on the machine or as a belt power unit

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Uses for Multicylinder Engine on a Dairy Farm

By A. J. Schwantes
FELLOW A.S.A.E.

WITH the purchase of a combine or a pickup baler, the farmer frequently gets an auxiliary engine that is used to drive the working parts of the machine. If the machine is used entirely or nearly so on only one farm and if the farm is of average size, the number of hours of annual use is not large. The idea of using such a power unit for other work on the farm presents some interesting possibilities. This paper deals with the possible uses of a multicylinder internal-combustion engine of about 20 hp on a general farm where dairying is the major enterprise.

Because the usefulness of such a power unit depends on such factors as size of farm, type of farming, and practices followed it seems advisable to assume specific conditions for this analysis. On a general farm on which dairying is the major enterprise there is a variety of work to be done. Also there are a large number of such farms in the Upper Mississippi Valley region. This type of farm seems to present a real challenge so far as the problem under consideration is concerned.

It seems desirable to choose a farm of a size and with crop acreages and livestock population that would be typical of a certain area. An opportunity for such a selection presented itself in the report of the Southeastern Minnesota Farm Management Service for 1940, 1941, and 1942[1]. This report contains a summary of the farm business data for 117 farms in 13 counties. The size of farm, crop acreages, and livestock population used as a basis for this problem are the average of these factors on the 117 farms.

From Table 1 it is seen that the average total acreage is 231 of which 171 are tillable. The total acreage of crops that may be harvested with a combine is 68.0, and there are 33.1 acres of hay. In Table 2 is shown the average character and magnitude of the livestock enterprises. There is also shown the homegrown grain fed annually and the amount that is ground.

Other available power with which the engine might be competing for work is an important consideration in studying possible uses for the engine. It is assumed that on this hypothetical farm there is a tractor with a drawbar capacity adequate to perform, within the necessary seasonal limits, all of the drawbar work and that the farm is supplied with electric energy from the high line with a transformer of 3 kva capacity. The tractor, electric motors, and 20 hp stationary engine are all capable of performing some of the belt work such as grinding feed, filling silo, elevating grain, and sawing wood. In the case of each of these forms of power the cost per unit of work will decrease as the amount of annual use increases. Although custom work would help to provide a satisfactory load factor, at least for the tractor and engine, it is assumed in this analysis that a significant amount of custom work is not to be depended upon. The possibilities that exist only on the farm are to be explored.

TABLE 1. USE OF LAND ON A HYPOTHETICAL DAIRY FARM IN SOUTHEASTERN MINNESOTA
(Average of 117 Farms)

Land Use	Acres
Flax	7.5
Cereals	53.6
Soybeans	6.9*
Corn, grain	36.0†
Corn silage	8.5
Alfalfa hay	20.3
Soybean hay	2.8
Other hay	10.0
Tillable pasture	22.9
Not cropped	2.9
Total tillable	171.4
Permanent pasture	29.6
Other	30.1
Total land in farm	231.1

*Includes 0.7 acre canning peas, 0.5 acre miscellaneous, and 2.3 acres sugar beets, hybrid seed corn, potatoes, and truck crops.

†Includes 1.7 acres sweet corn and 0.6 acre corn fodder.

TABLE 2. LIVESTOCK AND GRAIN FED ANNUALLY ON HYPOTHETICAL DAIRY FARM (Average of 117 Farms)

	Units	Grain per unit annually, lb		Total ground, lb
		Total	Ground	
Dairy cows	17.7	1982.0	1783.80	31,573.0
Other dairy cattle*	22.0	467.0	420.30	9,246.6
Pounds feeder cattle produced	1,461.0	8.41	2.68	3,915.4
Pounds hogs produced	21,193.0	4.51	2.04	43,233.7
Sheep, head (2 lambs = 1 head)	16.0	79.00		
Hens	217.0	99.00	25.00	5,425.0
Total				93,393.7

Assuming 150 lb per hp-hr with 15 hp, 2250 lb per hr could be ground. Therefore, 93,393.7 ÷ 2250 = 41.5 hr required to grind.

*Includes 4.3 head cattle in beef breeding herd.

In giving preliminary consideration to the particular power best suited to various jobs, certain obvious combinations of power and work suggest themselves. It is generally assumed that stationary belt work requiring comparatively small units such as pumping water and milking can best be done by electricity. The electric motor is easily started and stopped and comparatively trouble free if given reasonable care. However, in view of the availability on most farms of the farm tractor and possibly also the stationary engine, it seems impractical to provide larger than a 2 or 3-kva transformer for the farmstead. Electric power is handicapped in the case of equipment that is continuously or frequently moved. The tractor has the advantage of easy mobility, but since it is the only one of these three forms of power that is capable of doing drawbar work it must be used first for that work.

TABLE 3. OPERATIONS OR MACHINES REQUIRING STATIONARY POWER

Stationary thresher	Hay hoist
Combine	Silo filler
Grain elevator	Corn sheller
Pickup baler	Husker shredder
Hay chopper, stationary	Feed grinder
Blower for silage	Wood saw

In Table 3 are listed all of the ordinary operations or machines on this farm for which belt power, in relatively large units, is needed. Operations such as pumping water, milking, and separating cream that obviously can best be done with the electric motor have been omitted. Some of the operations shown, such as running the husker-shredder, corn sheller, and perhaps the thresher, are usually more conveniently performed with the tractor because the machines are frequently moved from one location to another. The tractor is convenient for doing such moving and to reset the stationary engine would be time consuming. The engine could be fastened to the machine itself and for some situations such an arrangement would be practical. An illustration is that of a farmer doing his own threshing. He has but one tractor to which a sweep rake is attached for bringing the bundles from the field. A sta-

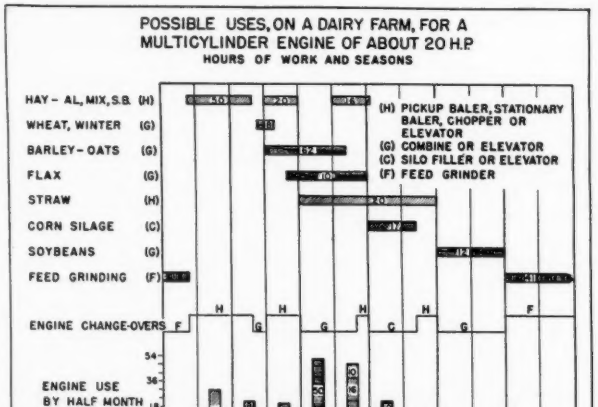

Fig. 1 Possible farm uses for a multicylinder engine

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[1]Nodland, T. R. and Pond, G. A., Summary Report of the Southeastern Minnesota Farm Management Service, 1940-42. Mimeographed Report No. 141, Division of Agricultural Economics, University Farm, St. Paul, Minnesota, October 1943.

tionary engine running the thresher would release the tractor for continuous use in hauling bundles.

Possible uses on the hypothetical farm for the stationary engine are indicated in Fig. 1. It is assumed that the engine may be used for making hay, threshing grain, handling combined straw, filling silo with corn, and grinding feed. In the case of most of these operations there would be one of several possibilities for using the engine and the hours of engine use would not be significantly different for the different operations. If the pickup baler is used for haying, the engine would be used on it. It could, however, also be used to elevate field-chopped grass into the silo or field-chopped hay into the mow or to operate a stationary chopper, stationary baler, or hay hoist.

The combine appears to be the most practical use for the engine in threshing, although it might be feasible in the operation of a stationary thresher and could be used on a grain elevator.

In handling combined straw, the pickup baler, the stationary baler, the chopper, or the elevator may be operated with the engine.

Corn for the silo is chopped with the stationary silo filler or the field ensilage harvester. The engine may be used to operate the stationary silo filler or the blower elevator in case the field ensilage harvester is used.

The use of the engine on a feed grinder of sufficient capacity to utilize most of its power appears practical, especially during the large part of the year that it cannot be used for other work.

Sawing wood is another possible use on some farms. Because of the limited possibilities both in number of hours and quantity of work and because the tractor, which is usually idle when wood is sawed, would be more convenient, this item is not included on the chart.

The period during which the work is normally done is shown for each kind of work in Table 4 and Fig. 1. The horizontal bars in the chart represent the periods. Data for these were obtained from farm management records of a number of farms in Winona County for 1935 to 1940 and Nicollet County for 1941 and 1942[2].

TABLE 4. PERIOD AVAILABLE AND WORKING TIME NEEDED

Operation	Period	Working time needed, hr
Making hay		
First cutting	June 12 - July 3	40
Second cutting	July 15 - Aug. 1	20
Third cutting	Aug. 15 - Sept. 2	10
Soybean hay	Aug. 15 - Aug. 30	6
Other hay	June 25 - July 6	10
Harvesting and threshing		
Winter wheat	July 12 - July 20	8
Barley and oats	July 15 - Aug. 21	62
Flax	July 25 - Aug. 31	10
Soybeans	Oct. 1 - Oct. 31	12
Baling straw		20
Making corn silage	Sept. 1 - Sept. 21	17
Grinding feed	All year	41
		256

The number inside each bar represents the actual time in hours required to do the quantity of work indicated by the acres in each crop. The time required for grinding feed is based on the amount of homegrown grain fed to livestock as shown in Table 2. In computing the actual working time required, good crop yields and moderate performance rates were assumed. Thus the time shown should be ample for most situations.

It is obvious that the time available is much greater than the time needed for all the work. On the other hand, the period for one operation overlaps that for another to a greater or lesser extent in the case of many of them. It would be convenient to assign each kind of work to a certain definite portion of the period for it and thus make possible more kinds of work on the same farm or the maximum amount of custom use for the engine. This part of the problem, however, is not simple because such variables as seasonal differences in time of maturity and weather conditions must be considered.

Only 20 hr are needed to harvest the second cutting of alfalfa during the last half of July. Because of variations in seasons the crop may be ready to cut by July 15 but may not be ready until July 20 or 25. There is no way of telling how much of that period will be rainy when hay cannot be made. Can it be assumed that the work will be continuous in so far as weather will permit or may other farm work interfere?

[2]Unpublished data furnished by S. A. Eugene, division of agricultural economics, University of Minnesota.

More can be done with this part of the problem than is here being attempted. From weather records the average and minimum time of favorable weather may be obtained for each period, thus showing approximately the amount of engine time not needed on this farm and available for work on some other farm or for other work on the home farm.

An assumed division of time for the engine is indicated by that part of Fig. 1 showing engine change-overs. To provide time for all of the work it was necessary to curtail rather drastically the limits of the periods for some. For instance, the second-cutting alfalfa harvest coincides rather closely with harvesting of winter wheat and overlaps the early part of the period for harvesting oats and barley. There is plenty of engine time available, even during the busy parts of the summer, but the problem is to avoid changing the engine from one machine to another oftener than necessary. Nine change-overs are shown in the figure. It is difficult to see how many of them could be avoided with the work requirement as indicated. If winter wheat were omitted from the list of crops, it might be possible to do the second-cutting alfalfa before changing to the harvesting of small grains and thus avoid the change from hay to grain and back again July 10 to 15. Although third-cutting alfalfa appears to cause some disturbance for only a small amount of work, it is assumed that at least some combined straw might be cared for at the same time. The harvesting of soybean hay also occurs during that period.

Certainly if this engine is to serve the farmer well it must be capable of ready change-over from one machine or operation to another. With this in view it appears that certain standard dimensions and arrangements could well be adopted by manufacturers of engines and of machines on which such engines would normally be mounted. The farmer also needs an easy and quick method of raising the engine out of a setting on one machine and placing it in position for another job. If he does not have facilities for doing this quickly and easily, he will not be inclined to make the several changes required during the course of the year.

An attempt has been made to determine the cost of using a 20-hp stationary engine under the conditions set forth in this discussion. The cost analysis is shown in Table 5. It was necessary to estimate the value of some of the factors, but in so doing care was exercised not to show a cost that might be too low for a reasonable annual use. It is significant that the overhead cost is only 10c per hr in comparison with 25c per hr for operating costs. Hence increasing, by only a moderate amount, the annual use would not appreciably affect the total cost per hour.

TABLE 5. COST OF USING A 20-HP ENGINE

Overhead Costs		
Depreciation (first cost ÷ life, or 300 ÷ 18)	$16.67	
Interest, average value at 6 per cent	9.00	
Total overhead, annual	$25.67	
Overhead, per hour (25.67 ÷ 256)		$ .10
Operating Costs		
Repair	$ 0.02	
Fuel, 1.5 gal at 14c	.21	
Lubricants	.02	
Total operating cost, per hour		.25
Total cost, per hour		$ .35

Interchangeable Power Units

(Continued from page 45)

for the power connection. All of the power take-off machines are well standardized as to power take-off speed and direction of rotation, so if the engine is installed in place of the power take-off shaft, all that is needed is to provide a standardized coupling. Each engine regardless of crankshaft speed can be equipped with a gearbox designed for that particular engine; that immediately provides power take-off speed at the stub shaft, and this assembly goes with the engine and should fit any machine.

If such a standardization program is carried out, I would expect future engine developments in this field along the line of lightweight construction, either in air-cooled or water-cooled engines with magnesium blocks and crankcases, aluminum heads, and pressed steel oil pans and flywheel housings.

Certainly the sale of auxiliary engines will be limited if a particular engine is confined in its use to a few days of operation on a particular machine. On the other hand, if the engine can be used for several jobs and in so doing release the tractor for other work in many cases, I believe there is a very large potential market.

A Report on Soil Tilth Research

THIS report is the result of current and all previous activities of the Joint Committee on Soil Tilth. It discusses soil tilth, considers the need for tilth research, presents a broad research program, and states specific objectives for 1944.

It is difficult and perhaps impossible to define tilth in terms that will meet with general approval. This results from the broad usage of the term by farmers, teachers, engineers, and soil and plant scientists. A particular individual using the term "tilth" is influenced by certain interests and defines tilth in terms of his interests. Depending upon interests tilth signifies to different individuals the act of tilling, the tilled layer, the zone of roots, the physical condition of the soil as it affects tillage, the physical condition of the soil as it affects plant growth, the feel of the soil, the physical condition of the soil, ease of handling, etc. Little can be gained by some particular group defining tilth in terms of their interests with the hope that others will use the term in the same sense. One way of avoiding difficulties is for each individual using the term in a publication to define tilth in the sense he intends to use it so that readers will not be misled. Another possibility is to coin a new term that can be restricted to a particular usage of the now-too-general term "tilth".

This report concerns the physical condition of the soil in its relation to life within the soil. The Committee has chosen the term "biophysical condition of soil" for this restricted meaning of tilth. Biophysical condition is not synonymous with physical condition. The physical condition of soil refers to a specific state of existence and can be described entirely in physical terms. A given physical condition may represent many biophysical conditions depending upon the soil, organism, and climate involved. While biophysical condition has a more restricted meaning than tilth, it is still far too general to permit us to deal with the separate entities in the entire system or with their interrelations. For this reason we have selected the term "specific biophysical condition of soil" which denotes the physical condition of a given soil in its relation to a particular organism in a particular climate. The specific biophysical condition of soil may then be evaluated in terms of plant response. When we have learned how to characterize the physical condition of soil adequately, we will probably be able to evaluate the specific biophysical condition in terms of soil qualities.

CHARACTERISTICS THAT INFLUENCE CONDITIONS

The soil characteristics that influence the biophysical condition are those that affect the air, water, and temperature relations and possibly also the resistance to penetration. On a given soil, temperature relations and the resistance to penetration are largely governed by the air and water regime. It follows probably that an adequate description of the air and water interrelations in a soil would characterize the physical state of that soil as it affects plants.

The description of the air-water regime involves a knowledge of the amounts and distribution of both air and water in the soil. It also involves a knowledge of rates of movement. Thus a puddled surface soil or a compacted horizon assumes great importance.

It must be recognized that the biophysical condition is continually changing. Even in a soil in which the physical state does not change with time, the biophysical condition changes with changes in the amounts of air and water present. Where the physical state changes with time as is usually the case, the biophysical condition fluctuates markedly. The physical state is altered greatly by tillage, by the action of rain, by growing roots, and other biological activities, by wetting and drying, by freezing and thawing, and by chemical weathering.

In the remainder of this report "tilth" is used synonymously with biophysical condition.

Need for Tilth Research. Approximately two-thirds of the total power consumption in farm draft work in the United States is expended in tillage. Over half this power is used in the basic operations of plowing and listing. One of the major objectives of tillage is to improve soil tilth. Cases can be sited where much of the money invested in tillage is wasted. Under other conditions, changes produced by soil manipulation effect such surprising increases in crop production as to suggest that an extension of the knowledge relative to the effects of tillage on soil and subsequent crop growth might lead to a more economic system of soil management.

Tillage experiments in the past have compared implements or number of operations in their effects on yield. In none of these experiments has soil tilth been evaluated either before or after tillage. It is not surprising that results obtained by one investigator do not agree with those obtained by others. Nor is it surprising that a treatise such as "Plowman's Folly" has received so much publicity. The reason soil tilth has not been evaluated in tillage experiments is that methods are not available by which it can be determined. Neither do we know with any degree of certainty what soil tilth is required for our important crop plants.

No amount of empirical experimentation will tell us whether subsurface tillage is superior to plowing, whether plowing is superior to disking, or what changes are desirable in the design of tillage machinery. Before we can make real progress we must know what soil physical state is desired for a given crop under specified climatic conditions. We must be able to measure the changes produced in soil tilth by our different management practices. A thorough fundamental study of soil tilth would seem to be of basic importance to agriculture.

A Program of Tilth Research. The Committee believes research must answer quantitatively the following questions:

1 What are the soil tilth requirements of our important crops, with respect to (a) air requirements, (b) water requirements, (c) temperature requirements, and (d) resistance to root penetration?

2 What is the soil tilth of a given soil before tillage?

3 How can soil in a given physical state be placed in a state having desired tilth, considering the (a) engineering aspects, (b) soil aspects, (c) cropping and microbiological aspects, and (d) environmental aspects?

4 How stable is the soil tilth created by tillage, as affected by (a) soil type, (b) previous cropping, (c) tillage, and (d) climate and weather?

5 Can guides be set up in terms of soil, crop, and environment to serve as a basis for engineering processes to establish desired tilth?

Organization of Tilth Research. Soil tilth and tillage present problems of national importance. Only by joint action of federal and state research agencies can we hope to obtain solutions to these problems.

PRESENTING PROBLEMS OF NATIONAL IMPORTANCE

In the foregoing incomplete analysis of the tilth problem, it is evident that certain phases of the research must be carried out under closely controlled laboratory conditions, (in deciding the tilth requirements of crops it will be necessary to control light, temperature, moisture, soil air, atmosphere, nutrients, and soil structure), while other phases of the research will require field plots under widely varying conditions. The Committee has already recommended that a national laboratory be established to study soil tilth and it reiterates that recommendation now. The Committee believes the tilth requirements of crops can best be ascertained at the national laboratory. All phases of the research would be cooperative between the national laboratory and the state experiment stations. It would seem desirable to divide the country into regions where problems were similar. A group of collaborators from each region would then work with the national laboratory in formulating a program of research for that region. Undoubtedly there would be certain phases of the program that could be best investigated by the state experiment stations while other phases would require the controls existing at the national laboratory.

Our conception of the national tilth laboratory is that, as it is an integral part of the U. S. Department of Agriculture, this program would not require the creation of any new agency or any reorganization within the Department. It would, however, require that funds be provided for the Bureau *(Continued on page 51)*

A report of the Joint Committee on Soil Tilth representing the American Society of Agronomy and the American Society of Agricultural Engineers, released by the Committee on November 17, 1943. The personnel of the Joint Committee on Soil Tilth consists of L. D. Baver, E. N. Fergus, L. B. Olmstead, and B. T. Shaw (general chairman) representing the A.S.A., and E. G. McKibben, J. H. Neal, M. L. Nichols, I. F. Reed, and A. P. Yerkes representing the A.S.A.E.

Performance of Irrigation Sprinkler Units

By L. H. Schoenleber

MEMBER A.S.A.E.

IRRIGATION of relatively small gardens is desirable, in areas where rainfall is deficient, in order to obtain high quality and high yields of vegetables. Individual irrigation sprinkler units may be used to apply water to small areas provided sufficient water can be supplied under pressure. Most farmsteads will normally have a pump to supply water for all domestic needs on a farm. The water supply may be from a shallow or deep well, a pond, a lake or a stream. The pump, which is already installed, will govern the head that can be pumped against and the amount of water that can be delivered. A pumping plant or windmill which is capable of pumping water under constant pressure will be suitable for operating individual sprinkler units. Care should be exercised to select a sprinkler which will operate satisfactorily with the pressure created and give even distribution of the water delivered. The sprinkler selected must be capable of handling all the water that is supplied, otherwise high pressures may develop in the water system causing damage. If the sprinkler selected is capable of handling more water under the pressure at which the water is being delivered, very poor distribution may result and the unit will not function properly. A pressure chamber equal to or larger than the piston displacement of the pump is desirable so that a steady flow of water will emit from the sprinkler.

In selecting a sprinkler unit to use, the characteristic curve for the pumping plant to be used under existing conditions may be superimposed on Fig. 2 to show the maximum discharge at different pressures. The point where this curve intersects the discharge curves for the different sprinkler units indicates the pressure at which the different sprinkler units would operate in case they were used. The broken dashed line in Fig. 2 is a characteristic curve for one water system and is used as an illustration. If the superimposed characteristic curve does not cross the discharge curve for some sprinkler units, it does not indicate that this unit could not be used with the water system under consideration. If the curves were extended, it is possible that the lines would cross, indicating the pressure under which the system would operate. For the most satisfactory operation, sprinkler systems used in these tests should be operated at pressures less than 50 psi.

There are many farm homes which have electric-driven water systems that might be used to advantage for irrigating small areas. Many different kinds and sizes of sprinklers are available, the choice being dependent primarily on the characteristics of individual sprinklers. It is highly desirable to select the sprinkler giving the highest uniformity coefficient.

Article prepared especially for AGRICULTURAL ENGINEERING.

Contribution No. 12 from the department of agricultural engineering, Kansas State College.

L. H. SCHOENLEBER is assistant professor of agricultural engineering, Kansas State College.

Units Tested. Several different types of sprinklers, shown in Fig. 1, were tested at Kansas State College to determine their characteristics and adaptability when operated with electric-driven water systems. The different types of sprinkler units under observation in these tests were (1) perforated pipe (3-in diameter), (2) floating rotary spray (Kennedy[1] type having eight 3/32-in holes), (3) rotary spray (single-action using 1/8, 5/32, 3/16, and 7/32-in nozzles), and (4) oscillating lawn sprinkler (using 13 large or 13 small nozzles). Water was supplied to sprinklers by an electric-driven water system equipped with 20-gal pressure tank and shallow well turbine pump and driven by a direct connected 1/2-hp electric motor. The pump had a normal capacity of 395 gph (gallons per hour) for low heads. The water level below the pump was 2½ ft.

Characteristics of Sprinklers. The discharge capacity for each sprinkler unit was determined for the lowest pressure under which it would operate and the maximum pressure obtainable with the electric-driven water system used, and for each 5 psi (pounds per square inch) pressure between the maximum and minimum pressure limits. The quantity of water discharged, area covered, and the uniformity coefficient for sprinklers operating at different pressures are shown in Table 1. Soil moisture cans were placed on two-foot squares on all sides of the sprinkler, and the water collected during each test was measured to the nearest cubic centimeter. It was apparent from the water collected in each can that the amount varied greatly over the area covered by each sprinkler. To compare the uniformity of distribution of the water of one sprinkler with another, a numerical expression was determined which was called the uniformity coefficient. The uniformity coefficient, expressed as a percentage, is defined by the equation, $C_u = 100\ (1 - \Sigma d/m\,n)$, where C_u is the uniformity coefficient, d is the deviation of individual observations from the mean m, and n is the number of observations. If even distribution of the water resulted, the uniformity coefficient would be 100 per cent.

Rate of Discharge. The performance characteristics of the electric-driven water system governed the maximum quantity of water discharged and the maximum pressure when operating each individual sprinkler. In order to determine the discharge at lower pressures, the quantity of water entering and leaving the water system required regulating. During these tests the operator manually controlled the inlet and outlet valves at the water systems.

The curves in Fig. 2 show the discharge of different sprinkler units in gallons per hour, using an electric-driven water system operated at different pressures. The perforated pipe with either one or two 10-ft sections and the floating rotary spray would operate with pressures as low as 2½

Fig. 1 Sprinkler units used in the test at Kansas State College. Upper left, perforated 3-in pipe, (10 ft long); upper right, floating rotary spray; lower left, rotary spray (single action); lower right, oscillating lawn sprinkler

[1]Kennedy sprinkler unit described in AGRICULTURAL ENGINEERING for June 1941, vol. 22, no. 6.

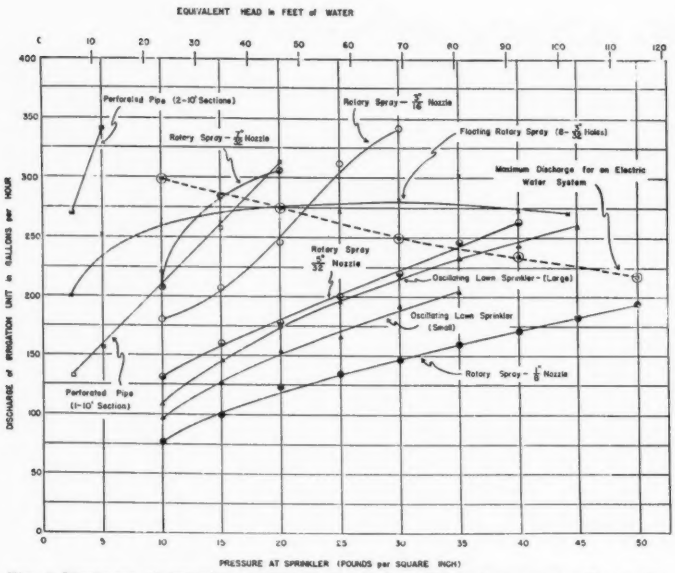

EQUIVALENT HEAD in FEET of WATER
DISCHARGE of IRRIGATION UNIT in GALLONS per HOUR
PRESSURE AT SPRINKLER (POUNDS per SQUARE INCH)
Perforated Pipe (2-10' Sections)
Rotary Spray — 5/16" Nozzle
Rotary Spray — 7/32" Nozzle
Floating Rotary Spray (8-1/32" Holes)
Maximum Discharge for an Electric Water System
Rotary Spray 9/32" Nozzle
Oscillating Lawn Sprinkler - (Large)
Oscillating Lawn Sprinkler (Small)
Rotary Spray — 1/8" Nozzle
Perforated Pipe (1-10' Section)

Fig. 2 Discharge of irrigation sprinklers operated at different pressures with an electric-driven water system

TABLE 1. CHARACTERISTICS OF DIFFERENT SPRINKLER UNITS OPERATED WITH ELECTRIC-DRIVEN WATER SYSTEM AT DIFFERENT PRESSURES

Description of unit	Pressure operated, psi	Average discharge, gph	Area watered, sq ft	Time required to cover area with 1 in water hr	Time required to cover area with 1 in water min	Uniformity coefficient
Floating rotary spray No. 3 (8-3/32-in holes	2½	200	204.5	0	38	23.2
	5	253	251.7	0	37	22.8
	10	259	336.5	0	49	14.9
	15	260	380.2	0	55	19.1
	20	268	324.6	0	45	19.7
	25	272	296.3	0	41	23.2
	30	280	304.0	0	41	31.8
	35	302	387.0	0	48	19.4
	40	272	376.8	0	52	16.1
	45	270	406.7	0	56	13.1
Perforated pipe (2 10-ft sections)	2½	270	502.4	1	10	50.3
	5	340	688.8	1	16	61.2
Perforated pipe (1 10-ft section)	2½	135	323.0	1	30	19.2
	5	159	501.1	1	58	27.1
	10	220	710.4	2	1	29.9
	15	261	853.8	2	2	33.5
	20	312	821.8	1	39	41.9
Oscillating lawn sprinkler (large nozzles)	10	112	1212.8	6	45	43.4
	15	147	1676.2	7	7	47.3
	20	175	2276.5	8	5	39.9
	25	195	2681.6	8	34	63.1
	30	215	3084.0	8	57	44.3
	35	232	3010.6	8	5	45.3
	40	244	3093.1	7	54	30.6
	45	260	3107.2	7	27	35.0
Oscillating lawn sprinkler (small nozzles)	10	97	1198.1	7	42	51.8
	15	128	1709.4	8	20	46.8
	20	152	1965.4	8	4	48.4
	25	168	2582.4	9	35	45.5
	30	193	2727.0	8	49	23.3
	35	204	2579.2	7	53	46.0
Rotary spray, Rainbird No. 20 (single action, ⅛-in nozzle)	10	76	1963.0	16	6	4.0
	15	100	3419.0	21	13	6.1
	20	124	4013.0	20	10	7.5
	25	132	4715.0	22	13	20.2
	30	148	4899.0	20	38	24.7
	35	160	5539.0	21	35	33.4
	40	172	5672.0	20	34	41.2
	45	180	5738.0	19	52	43.4
	50	196	5942.0	18	54	45.0
Rotary spray, Rainbird No. 20 (single action, 5/32-in nozzle)	10	133	1923.0	8	54	33.8
	15	160	2826.0	11	1	42.1
	20	176	3737.0	13	14	61.7
	25	200	4334.0	13	35	58.2
	30	220	4534.0	12	51	52.1
	35	248	4776.0	12	0	54.3
	40	264	5087.0	12	1	56.8
Rotary spray, Rainbird No. 20 (single action, 3/16-in nozzle)	10	180	1385.0	4	49	47.8
	15	208	2123.0	6	22	50.2
	20	248	2826.0	7	6	53.5
	25	312	3577.0	7	9	57.3
	30	340	3792.0	6	56	61.7
Rotary spray, Rainbird No. 20 (single action, 7/32-in nozzle)	10	208	803.0	2	24	42.2
	15	284	1809.0	3	58	48.2
	20	308	2205.0	4	28	58.6

to 5 psi. All other units required 10 psi pressure to operate them.

Normally sprinklers would discharge more water with increased pressure. This held true in these tests for all sprinklers except the floating rotary spray unit. This sprinkler was so designed as to discharge very nearly the same quantity of water regardless of pressure. There was a maximum difference in discharge for this sprinkler of only about 50 gph between pressures of 10 and 45 psi. All units tested where different sized nozzles were used showed that in every case the unit having the larger nozzle discharged more water at the same pressure.

Area Covered by Each Unit. The area over which water was distributed for given pressures was greatest when using the smallest nozzle on the rotary spray unit. Most sprinkler units equipped with the smaller nozzles would water a larger area for one sprinkler setting. This did not always hold true while using the oscillating lawn sprinkler. The curves in Fig. 3 show the areas covered by each sprinkler when operating at different pressures. The oscillating lawn sprinkler ranked second in maximum area covered for different pressures. The perforated pipe ranked third in size of area covered. The area covered by the floating rotary spray sprinkler showed less variation and ranked last of all units tested. The size of hole made in the floating rotary sprinkler was not changed. The holes could be made of different sizes, depending upon the size of bit used to drill the holes. Likewise, the number of holes could be varied. These factors were not investigated in this study, but would undoubtedly affect the area covered for different pressures.

Time Required to Apply Water. The time required to apply one inch of water to the area covered by one sprinkler setting with different irrigation units when delivering different quantities of water is shown in Fig. 4. As previously indicated, the quantity of water discharged increased with greater pressures for all sprinklers except the floating rotary spray. Likewise the area covered increased more rapidly than the rate of increase of discharge up to a certain point, then the reverse condition existed. This explains why the time required to apply one inch of water to an area covered by one sprinkler setting was lower for the lowest and higher pressures. In most cases the time required to apply one inch of water was the greatest

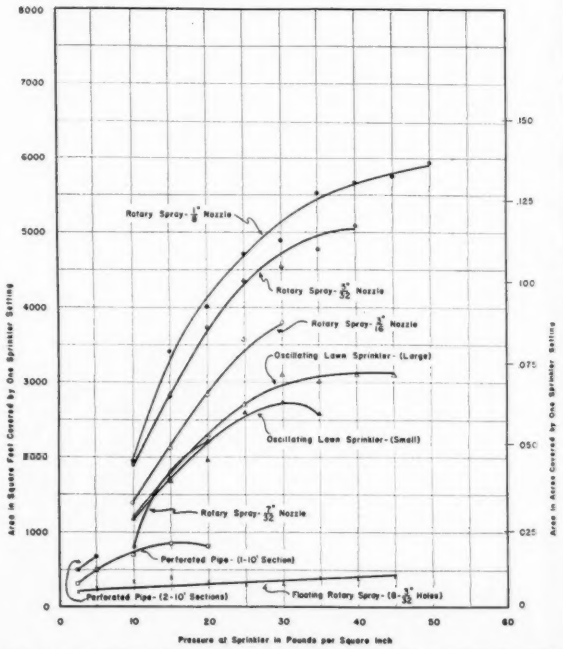

Area in Square Feet Covered by One Sprinkler Setting
Area in Acres Covered by One Sprinkler Setting
Pressure at Sprinkler in Pounds per Square Inch
Rotary Spray- 1/8" Nozzle
Rotary Spray- 9/32" Nozzle
Rotary Spray- 5/16" Nozzle
Oscillating Lawn Sprinkler - (Large)
Oscillating Lawn Sprinkler - (Small)
Rotary Spray- 7/32" Nozzle
Perforated Pipe - (1-10' Section)
Perforated Pipe - (2-10' Sections)
Floating Rotary Spray - (8-1/32" Holes)

Fig. 3 Area covered by each sprinkler when operated at different pressures

for some pressure between the maximum and minimum pressure at which the unit was operated. The least time was needed to apply one inch of water to the area covered when using the floating rotary spray unit. The perforated pipe ranked next, and the rotary spray unit using 1/8-in nozzles required the most time.

When an equal quantity of water was applied on a unit sized area with different sprinklers, indications were that the least time was required for the same pressure using the two sections of 10-ft perforated pipe, floating rotary spray ranked second, one 10-ft section of perforated pipe ranked third, rotary spray ranked fourth using the 7/32, 3/16, 5 16-in nozzles. The oscillating lawn sprinkler using the large nozzle ranked last. For the sprinklers mentioned above, the time required to irrigate a given quantity of water on a given area decreased for increased pressure for each unit. The variation in time at a given pressure varied as much as from 200 to 300 per cent for different systems.

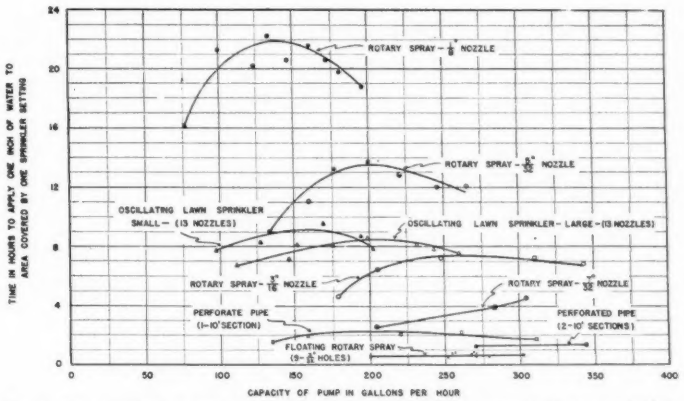

TIME IN HOURS TO APPLY ONE INCH OF WATER TO AREA COVERED BY ONE SPRINKLER SETTING
CAPACITY OF PUMP IN GALLONS PER HOUR
ROTARY SPRAY - 1/8" NOZZLE
ROTARY SPRAY - 7/32" NOZZLE
OSCILLATING LAWN SPRINKLER SMALL - (13 NOZZLES)
OSCILLATING LAWN SPRINKLER - LARGE - (13 NOZZLES)
ROTARY SPRAY - 3/16" NOZZLE
ROTARY SPRAY - 5/32" NOZZLE
PERFORATE PIPE (1-10' SECTION)
PERFORATED PIPE (2-10' SECTIONS)
FLOATING ROTARY SPRAY (9-1/8" HOLES)

Fig. 4 Time required to apply one inch of water to the area covered by one sprinkler setting when delivering different quantities of water

A comparison of the number of settings for a sprinkler to water a given sized area may easily be determined by a simple calculation. The area watered by different sprinklers operated at different pressures may be obtained from Table 1 or Fig. 4.

Uniformity of Water Application. The uniformity of water application was determined for all units and is expressed as the uniformity coefficient. The uniformity of application of water using more than one rotary sprinkler has been previously determined by Christiansen[2]. The uniformity coefficient which has been previously defined is shown in Table 1. The oscillating sprinkler equipped with small nozzles showed the highest consistent uniformity coefficient varying from 45.5 to 51.8 when operated at different pressures. The highest uniformity coefficient obtained was 63.1 with the oscillating sprinkler equipped with large nozzles operating at 25 psi pressure. The floating rotary spray and rotary spray using 1/8-in nozzle showed the lowest uniformity coefficient, and the greatest variation, or 13.1 to 31.9 and 4.0 to 45.0, respectively, for different pressures. The perforated pipe operated at different pressures also showed the uniformity coefficient varying widely.

Current Requirements. The number of kilowatt-hours consumed per hour in operating sprinkler units with electric-driven water systems may be determined from Fig. 5. The dotted line in Fig. 5 shows that about 0.24 kw-hr per hr were required to pump 200 gph against a 115-ft head with a pumping plant efficiency of 30 per cent.

[2]Christiansen, J. E. The Uniformity of Application of Water by Sprinkler Systems. AGRICULTURAL ENGINEERING for March 1941, vol. 22, no. 3.

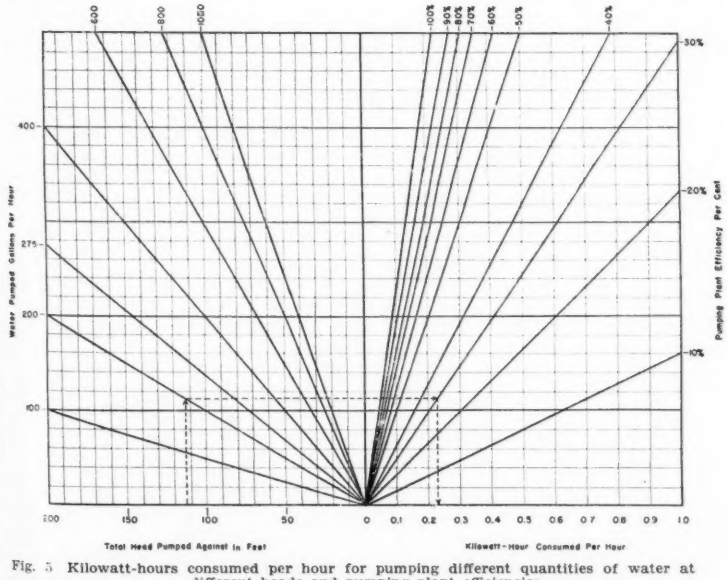

Water Pumped Gallons Per Hour
Pumping Plant Efficiency Per Cent
Total Head Pumped Against in Feet
Kilowatt-Hour Consumed Per Hour

Fig. 5 Kilowatt-hours consumed per hour for pumping different quantities of water at different heads and pumping plant efficiencies

A Report on Soil Tilth Research

(Continued from page 48)

of Plant Industry, Soils, and Agricultural Engineering to establish and operate additional facilities consisting of laboratories, greenhouses, various control apparatus, etc., for studying the plant physiological effects of various tillage practices and conditions of tilth and to supplement and work in connection with the machinery tillage laboratory. The activities of the laboratory would be decided cooperatively by the several states, the Soil Conservation Service, and the Bureau of Plant Industry, Soils, and Agricultural Engineering. We feel that tilth is a pressing problem of national concern and as such merits national attention.

Objectives for 1944. The Committee realizes that very little new work on tilth will be possible until after the war. Also, granting that a program such as the one proposed is adopted, it will be some time before plant requirements can be evaluated. Because of this it would appear desirable to evaluate, in so far as possible, the changes produced in the physical state of soil by our present tillage implements. This knowledge is certain to be the basis of any future activities aimed at creating desired tilth.

Many experiment stations are now comparing plowing with subsurface tillage. It may be that it would be possible to include disking also. These three methods constitute our present essentially different approaches to seedbed preparation. In one the residues are turned under, in another left on top of the ground, and in the third the residues are mixed in the surface soil.

The Committee recommends that as many experiment stations as can do so compare these three methods of tillage on one or more important crops. In addition to yields, as much information should be obtained as possible that will reflect on the air-water regime in the soils studied. In the event the physical studies cannot be made, it will be enlightening to have yields only.

The Committee further recommends that it be authorized to submit this report to each of the directors of the several state agricultural experiment stations for their consideration. If a majority of the directors believe that a program along the lines suggested in this report is desirable, the report and the statements of the directors shall be submitted to the Administrator of Research of the U. S. Department of Agriculture with the request that he approve the program and take such steps as are necessary to put it into effect as soon as conditions permit.

A Report on Home Dehydration of Food Products

By G. E. Henderson
MEMBER A.S.A.E.

AS SCIENCE progresses there are often terms developed that are perfectly clear to technicians but quite confusing to the average person; for example, such terms as "electronics" as related to electricity and "power factor" as related to efficiency. The same confusion exists with the term "dehydration" as related to drying when applied to food preservation.

We can agree that "dehydration" is the term applied when water is rapidly and uniformly removed from products under controlled conditions of heat, humidity, and air movement, as contrasted with "drying" which has come to be regarded as removal of water by use of uncontrolled temperatures and without forced circulation of air. To my knowledge no one has ever said that if one or two of the conditions are controlled the process can be called dehydration. Not only that, but no authority has said if all three conditions can be controlled but aren't that we can call the product "dehydrated".

Early in 1943, with the sudden surge of interest in home dehydration, agricultural experiment stations, extension services, and others issued instructions on homemade dehydrators and many units no doubt were used during the year. However, with the scarcity of equipment, materials, and labor, many homemade dehydrators were not put into operation until late in the season. Manufactured dehydrators did not appear on the market until the latter part of August, which was too late to be of much value in preserving food this year. As a whole, it might be considered that home dehydration was largely in the experimental or introductory stage, as far as home use was concerned, resulting in rather limited experience.

Fortunately, in spite of grave misgivings last year in regard to the supply of glass jars and covers, there appeared to be a sufficient amount to meet the demand, at least in the Southeast. Tin cans for community and home canning were also available. This does not imply that all of the food that could have been preserved in the home was saved. If there had been more home dehydration equipment, pressure cookers, and other food preservation equipment available earlier in 1943, a greater amount of food would probably be on pantry shelves.

Home dehydration became popular with the public early in 1943, as being a solution to our wartime civilian food preservation supply problem. Proponents and opponents alike hit the headlines in a battle of words over the merits and demerits of dehydration. In the meantime the general public looked upon any equipment that would extract water from food as being a "dehydrator", regardless of heat, air flow, humidity control, or drying time involved. Those who have a sincere interest in making contributions to the science of dehydration, whether it is done in the home, in a community plant, or by a commercial concern should be glad this hysteria is over. We can now look realistically at the problem and cooperate in a mutual effort to reach the solution.

First, let's see what impressions have been gained by users of dehydrators (not driers). Last fall our organization, in cooperation with the agricultural extension services of Mississippi, Alabama, and Virginia, made more than 30 spot surveys of dehydrator users plus many more by mail. The impressions secured were gained from users after they had had from one to four months' experience dehydrating such products as apples, green beans, corn, peas, okra, lima beans, peaches, carrots, beets, pears, squash, onions and rhubarb, plus small quantities of sweet potatoes, Irish potatoes, figs, kale, turnip greens, and broccoli. A summation of those reports is as follows:

1 It is generally believed that it is less trouble to dehydrate than to can.
2 Dehydration is well adapted to areas where cellar storages are lacking.
3 Dehydrated products are much higher in quality than sun or stove-dried products.
4 The small, light-weight containers are desirable for families who move often, and where storage space is limited.
5 Dehydration costs less than canning.
6 Some products, such as corn, peas, and green beans can be kept with less risk of loss as compared with canning, even when canning is done in a pressure cooker.

In contrast with this is what farmers are saying against dehydration:

1 Commercially constructed dehydrators cost too much.
2 Sulfuring of fruits is too much trouble and sometimes a rather disagreeable task.
3 Many have had the bad experience of uneven drying on the trays from top to bottom.
4 Instructions for preparation of the products, operating the dehydrator, packaging, storing, and refreshing are not consistent and in most instances inadequate.
5 Dehydration in its present development is a "war baby".
6 In planning meals allowance has to be made for a longer period of preparation.

Admittedly impressions of farm people with only one to four months' experience are not very conclusive. At best it serves only to indicate how users were thinking at that stage of the development.

The best we can do then is to take their impressions plus our field observations, laboratory experience, and reports from other states and see how they add up. As nearly as we can determine it is about as follows:

1 A number of users who now appear satisfied with their dehydrated products will be dissatisfied when they use them because they did a poor job of preparation, or dehydrating, or packaging, or storing, or all four. Some were laboring under false impressions or guided by misinformation. Still others are inclined to can or freeze their best products and dehydrate their poorest. This happened in spite of educational efforts.

2 Fruits such as peaches, apples, prunes, and figs, plus some vegetables such as corn, lima beans, and okra, are already well accepted by users who have dehydrated them, particularly if they have been accustomed to drying such products and are following good processing, packaging, and storage practices. Since the vegetables are of the more difficult type to keep when canned and are relatively easy to dehydrate, plus the fact that all are definitely superior in quality than when sun or stove dried, it appears that dehydration is now definitely in the home food processing picture.

3 As compared with freezing, home dehydration will not become popular with those who can afford that service, unless dehydration technique can be simplified and improved over what it is now.

4 The marketing of a low cost ($25 or less), efficient and attractive dehydrator, as nearly automatic as possible, accompanied by effective instructions for processing, dehydrating, packaging, storing, and refreshing, will greatly enhance the chances of dehydration becoming popular. A number of manufacturers think this is possible and plan to make such an effort. Plans for home-constructed units of good design must be made available for vocational shops, basement mechanics, etc.

5 Improper packaging and too warm storage can easily be the pitfall for dehydration. Vaportight, lightproof, and insect-resistant packages must be made readily available and the products stored where it is cool if quality is to be maintained.

6 Additional research is needed. Preparatory treatment techniques, more accurate temperature and humidity control, methods for increasing speed of dehydration, new or improved packaging materials, improved dehydrator construction, better tray material, and varietal adaptability along with optimum stages of maturity of vegetables, are some of the research problems yet unsolved. Much of this research is planned or now under way.

7 To compete with canning as an over-all method of preservation the dehydration processes need simplifying and over-all quality must be equal or superior to offset the inconvenience of a longer preparation period before serving. *(Continued on page 55)*

Paper presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1943. A contribution of the Rural Electric Division.

G. E. HENDERSON is assistant chief, agricultural engineering development division, Tennessee Valley Authority.

Two Devices for Measuring Soil Erosion

By W. D. Ellison
MEMBER A.S.A.E.

THE author has been using two devices he constructed for measuring soil erosion, and it is believed they may be useful to others working on similar problems. One of the devices is used in collecting a sample from the splash of raindrops, and the other is used in sampling the surface flow. Analyses of the soil contained in each of these samples tends to show the effectiveness of the separate factors of rainfall and overland flow in producing erosional activity and in causing erosional damage to the land.

Erosional activity which displaces and moves soil materials from initial positions, whether caused by raindrops or by overland flow, may result in considerable erosional damage to the land. Such damage includes (1) developing a "spotty" soil through making the thin soils thinner and the thick soils thicker; (2) burying topsoil under deposits of subsoil either on hillsides or in valley bottoms; (3) depleting soil fertility elements; and (4) changing soil structure and other soil properties.

These damages occur when soil materials are displaced and moved from initial positions. Displacements are caused by both raindrops and overland flow. They may not be uniform over large areas, and usually they vary on each small increment of slope length, from the crest of the hill to the bottom of the valley. These variations often make it impossible to evaluate erosional damage in terms of total soil loss as measured in the runoff. A field may suffer considerable erosional damage without appreciably large amounts of soil loss, and with very little or no runoff. On the other hand, it is possible to have relatively large amounts of erosional debris (including subsoil materials) carried away in the runoff waters without suffering much erosional damage.

It is not the author's idea that the two devices shown in Figs. 1 and 2 should replace other instruments used to measure soil erosion, but rather that they should be used in addition to other devices. With these two devices studies can be made of the distribution and the nature of the erosional activity occurring over a watershed. This information will be helpful in determining erosional damage, the nature of the damage, in determining causal factors and in evaluating corrective measures applied.

The splash sampler shown in Fig. 1 is used to collect a sample of raindrop splash. It has been installed with the upper edges of boxes A and B set ½ in above the soil surface. A very small amount of rainfall splashes into the boxes directly, but the greater part is intercepted by the 5 x 6-in splash board. Soils which do not fall into the sampling cans can be washed down with a small spray of water at the time soil samples are to be removed.

Laboratory analyses have been made to determine quantities of soil contained in the splash, and particle sizes and aggregate distribution. These results have been found very useful in studying erosion phenomena. Among other things these data are useful in determining (1) how much soil erosion and movement is caused by raindrops; (2) what particle and aggregate sizes are carried by the splash; (3) whether or not raindrop erosion tends to change the physical characteristics of the soil by moving only certain particle and aggregate sizes; (4) if soil aggregation is increased or decreased, whether it will reduce or increase this erosional process; (5) which soils are most susceptible to raindrop erosion and which are least susceptible; (6) which canopies and mulching practices are most effective for controlling this erosion; (7) how much reduction or elimination of raindrop erosion reduces the total erosional activity and what effect this reduction has on erosional damage and soil loss.

There should be many other uses for these data, such as determining how much more of the splash is moved down hill than up slope. These differences can be studied through installing the sampler on the contour and noting quantities collected in A and B, Fig. 1. One of these samples should indicate how much soil the raindrop splash moves down slope and the other should indicate the amount moved up hill. Undoubtedly these movements change with changes in slope.

Another study can be made as to the effect of wind on raindrop erosion. Often when rainstorms are accompanied by high winds, most of the raindrop splash moves in the direction that the storm travels, and where this travel is down slope the effects of the wind on increasing a down hill movement of soil may be very pronounced.

The flow sampler shown in Fig. 2 is used to sample the overland flow. Samples are collected from slot B. This device can be carried around over the area and samples taken at representative locations, or if preferred it can be installed permanently with a small collector tank connected to slot B. Drifting debris may be troublesome with permanent installations, but since failure of several instruments may not upset the whole record, this trouble should not be too serious. It is believed, however, that a better job of sampling can be done by carrying the device around over the area. Usually conditions change from storm to storm and these changes may make it desirable to change sampling points in order to obtain representative samples.

(Continued on page 55)

Article prepared especially for AGRICULTURAL ENGINEERING.

W. D. ELLISON is project supervisor, North Appalachian Experimental Watershed, Soil Conservation Service, U. S. Department of Agriculture.

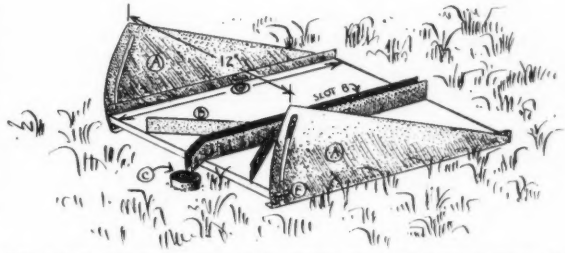


Fig. 2 The flow sampler. A, sides slotted for adjustment to slope; B, slot through which sample flows; C, collection can; D, deflection fins; E, wingnuts to adjust slope of floor of sampler; G, over-all length depends on slope

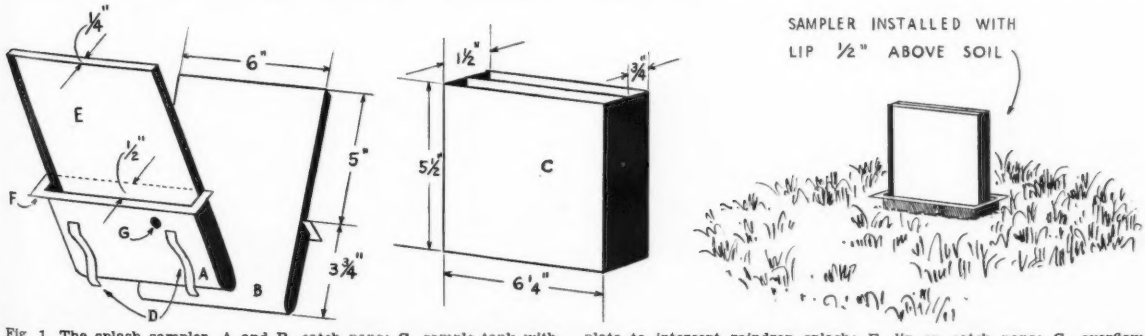


Fig. 1 The splash sampler. A and B, catch pans; C, sample tank with watertight division; D, friction springs to hold pans in tank; E, splash plate to intercept raindrop splash; F, lip on catch pans; G, overflow into C for temporary storage

Coordination of the Dimensions of Building Materials and Equipment

By John A. Ruhling

THE idea of standardizing building products of all kinds so they will fit together readily, eliminating unnecessary hand fitting on the site and reducing the variety of stock sizes required, has been the dream of the building industry for years.

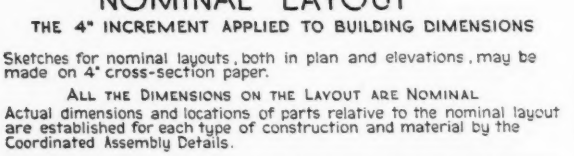
To make possible a cooperative industry approach to the problem, the American Standards Association in September, 1938, held a conference of producers of building materials, which recommended to A.S.A. that a project on dimensional coordination be developed, with the result that A.S.A. Project A62 was initiated early in 1939 with the American Institute of Architects and the Producers' Council as sponsors.

As authorized by A.S.A., Project A62 comprehended the study and development of dimensional coordination as the solution of a basic problem, with no commitment to adopt or follow any preconceived method of solutions. A sectional committee was organized, composed of representatives of the producing industry, architectural and engineering societies, government agencies and others interested in the use of building materials. The project has proceeded under the following scope: (a) The development of a basis for the coordination of dimensions of building materials and equipment and the correlation of building plans and details with dimensions, and (b) the recommendation of sizes and dimensions as standards suitable for dimensional correlation.

As a result of comprehensive studies previously made by Albert Farwell Bemis (well known for his research in support of the dimensional coordination method) and others, the A.S.A. sectional committee in 1939 tentatively adopted a 4-in layout unit or module as the basis for coordination. This size module was chosen because it was most adaptable to present building practice. Accordingly steps were taken to test its application to building materials generally, and the sectional committee organized specialized study on this program by the following working subcommittees: (1) Masonry made of structural clay products; (2) wood doors and windows; (3) masonry made of concrete and cast stone; (4) metal windows; (5) natural stones, including granite, limestone and marble; (6) structural wood; (7) building layout; (8) structural steel, and (9) miscellaneous metal products. The studies made by these subcommittees have led to recommendations for adoption of "application standards" for certain of the materials studied.

The application standards will provide the manufacturers of particular materials and products with modular product sizes applicable to these materials and products. Acceptance by designers is the first prerequisite to adoption of coordination. The various study committees have proceeded to the point where it can be said generally that it is feasible to correlate building plans and details through the proposed basic standards as well as to fix standards, coordinated sizes and dimensions of building materials and equipment.

The study subcommittee (No. 7) on building layout is determining the methods through which building plans and details may be so correlated. This subcommittee is testing the correlation of building plans and details through application of coordinated or modular design to specific projects now being planned for post-


NOMINAL LAYOUT
THE 4" INCREMENT APPLIED TO BUILDING DIMENSIONS
Sketches for nominal layouts, both in plan and elevations, may be made on 4" cross-section paper.
ALL THE DIMENSIONS ON THE LAYOUT ARE NOMINAL
Actual dimensions and locations of parts relative to the nominal layout are established for each type of construction and material by the Coordinated Assembly Details.

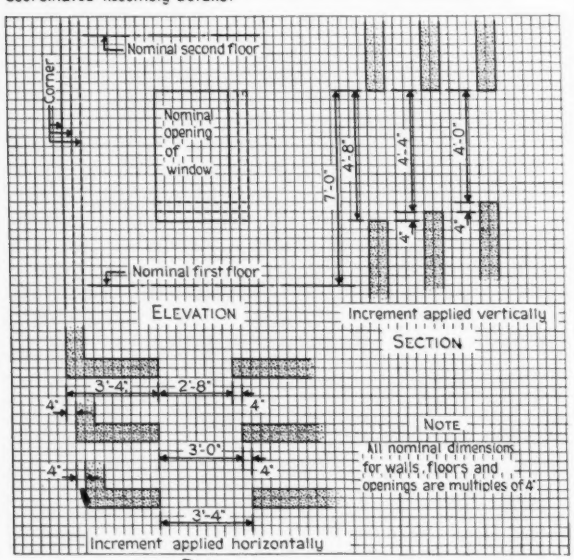
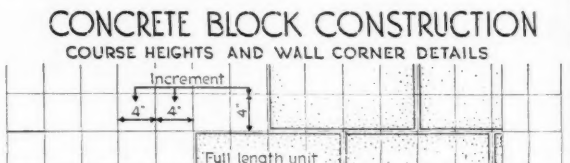
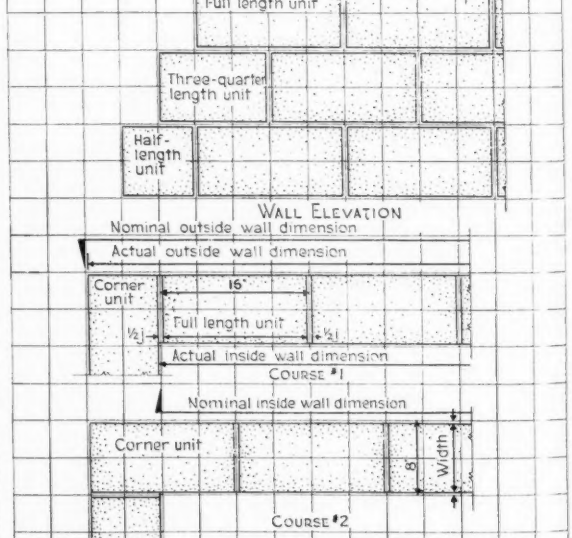


Fig. 1 The basis for correlation of building plans





Based on a ⅜" JOINT THICKNESS, which has been suggested by the Study Committee for adoption by the industry as suitable for concrete block construction, the actual block dimensions would be: actual height – 7⅝", actual length – 15⅝", actual width – 7⅝".

Fig. 2 The basis for correlation of assembly detail

Paper presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1943. A contribution of the Farm Structures Division.

JOHN A. RUHLING is assistant manager, cement products bureau, Portland Cement Association.

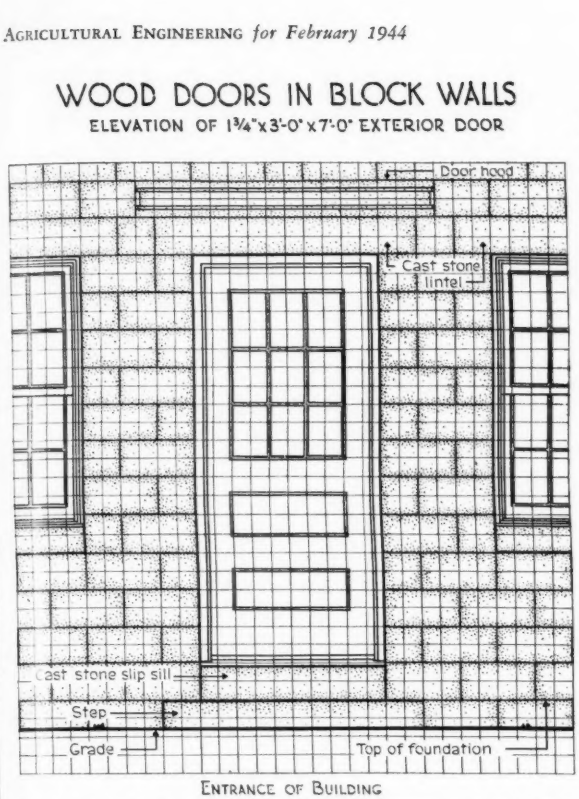


Fig. 3 The basis for correlation of concrete masonry units and doors and windows

war construction. The information this committee will issue will adequately inform the designer that preparation of building plans and details under this project is practical.

I have attempted to give you the background of this A.S.A. activity including the scope of the various study subcommittees. Now let us consider the 4-in module as applied to concrete masonry units. The modular system as applied to masonry can be defined as a relationship of sizes for the parts that are assembled during building erection, which will facilitate their assembly and the correlation of the dimensions of the building with these sizes by a simple method of building layout.

The object of modular coordination is economy. This is realized through simplified working drawings and elimination of construction wastes, both labor and materials. Economy is also realized through reduction in varieties and comprehensive standardization of product sizes to be manufactured, distributed and handled.

The coordination of the dimensions of building materials and equipment does not contemplate standardizing of building design.

The concrete masonry industry would require less change than any other industry in order to meet the requirements for the coordination of the dimension of masonry units. It would in fact conform now to the new basis for coordinated dimension if it could maintain a ¼-in joint. Experience shows that in practice masons generally work to a ⅜-in joint. Accordingly if the industry is to adopt concrete masonry to the modular system of coordination, the actual size of a standard 8-in unit would be 7⅝x7⅝x15⅝ in.

The board of directors of the National Concrete Masonry Association favors the adoption of the American Standard basis for the coordination of concrete masonry and is prepared to cooperate in every way to advance this work. Several sash and door manufacturers are working on the problem and have cooperated with the concrete masonry industry in an exchange of ideas based on combination of concrete masonry units and wood sash and doors.

Approval of adoption of modular masonry standards is also rapidly gaining favor in the structural clay products industry. Several groups of these manufacturers have agreed to manufacture clay masonry units in modular sizes for postwar markets, as soon as a demand for these products arises.

By the adoption of the modular sizes every step in the planning and building of farm structures will be simplified as a result of working to a uniform coordinated size, not only concrete masonry but other products that must be fitted with them into walls. Costs are cut in designing, it will eliminate the tedious and costly job of cutting units on the job to fit odd lengths or heights, and it will result in neater and speedier erection.

Farm building plans designed by the agricultural engineers of the Portland Cement Association are incorporating the fundamentals of modular design. Much is heard about the package idea of purchasing farm structures and many farm structures are sold in this manner. This package idea is gaining acceptance, for the farmer can select plans to meet functional requirements and have the assurance that after he has assembled the various building materials his construction problems are minimized. Furthermore, the combined effort of designers and manufacturers throughout the building industry surely will bring about a stimulated demand for stock sizes in preference to special sizes because of their more convenient use and economical field construction.

Home Dehydration of Food Products

(Continued from page 52)

8 Technique in refreshing is definitely lacking with new users. Education and experience will gradually overcome this.

9 To those interested in low cost food processing, dehydration ranks number one. According to the best figures we are able to get together, the over-all cost of processing and keeping 100 quarts in the home by freezing is $9, by canning $3.50, by dehydrating $2.70. These figures are exclusive of labor.

What are the general conclusions? I believe we can conservatively say that home dehydration equipment will gradually replace the older methods of drying, providing low cost, efficient equipment in the form of fan-heater-thermostat kits or commercially built cabinets become available. Unless unexpected shortages of materials for home canning occur, there will not be a major change made during the war in home food preservation methods. The long-time program of home dehydration can only be linked with technological advances in this and other forms of food preservation.

AUTHOR'S ACKNOWLEDGMENT: Acknowledgment is given for information supplied by the Nebraska, Ohio, South Carolina, Virginia, Alabama, and Mississippi state agricultural extension services, the Nebraska and Oregon agricultural engineereing departments, the Tennessee Agricultural Experiment Station, and staff members of the agricultural engineering development division of the Tennessee Valley Authority.

Devices to Measure Soil Erosion

(Continued from page 53)

Data obtained from analyzing these samples should be useful in determining (1) how much soil is being moved by the runoff; (2) when are greatest amounts of soil eroded by overland flow and what is the effect of seasonal changes on this process; (3) what is the origin and probable destination of soils carried by surface flow; (4) how much erosion is caused by overland flow when raindrop erosion is inactive; (5) whether or not overland flow carries all of the materials eroded by raindrops, and, if not, what per cent of each particle and aggregate size it carries; (6) whether increased or decreased aggregation increase or decrease erosion by overland flow; (7) how effective the different crop and tillage methods are in preventing erosional damage by overland flow and what is achieved through constructing terraces and diversion ditches.

There may be other uses for data obtained with these two instruments. The author's principal reason for constructing them was to obtain separate samples of the erosion caused by raindrops and that caused by surface flow, for purposes of facilitating some studies in erosion problems. This objective has not been fully achieved in that erosion by overland flow cannot be determined with a high degree of exactness except where there is no raindrop erosion. Even though these devices do not fully solve the original problem, they do contribute to its solution, and it is thought that in addition to advancing different phases of research work, these sampling devices will contribute to better evaluations of erosion control practices.

Some results obtained in studies where these devices were used are reported in a paper entitled "Studies of Raindrop Erosion" (unpublished), by the author.

Forage Problems for Engineers

To the Secretary of A.S.A.E.

THE interest shown at the round table of the Committee on Hay Harvesting and Storage of the American Society of Agricultural Engineers at the Society's recent fall meeting in Chicago was to me indeed gratifying.

C. E. Seitz of Virginia discussed the problem of drying hay by forced circulation which provoked considerable discussion. The matter of field baling was aired in such a way as to lead me to believe that considerable attention will be given to the field pickup baler by A.S.A.E. members.

Silage and the field chopping of dry hay did not come up for discussion, neither did quick dehydration, but these methods of grass preservation will undoubtedly receive in due course whatever attention they merit.

The problem of forage preservation is one which has been delayed altogether too long. The real importance of grass in our agricultural economy has been greatly overlooked, probably because it is such a common crop and also because it is difficult to visualize as a cash crop.

We are inclined to overlook the fact that it is impossible to get along without any or all of our other major crops and still maintain livestock production, but were we to deny our livestock grass in its various forms for any considerable length of time the livestock would cease to exist.

It is significant that more wars have been fought over the control of grassland than over any other single thing. The tribal wars of the ancients, medieval battles and modern struggles between nations can trace many of their beginnings to the desire for control of grassland areas.

Ninety million tons of dry tame hay (equivalent to 270 million tons of grass silage) together with 40 million tons of corn and sorghum silage, to say nothing about the millions of tons of forage from soybeans, sweet potato vines, peanut vines, etc., is an annual forage crop which bulks large in our total annual agricultural production, even though it does not show directly on the cash side of the farmer's ledger.

The hidden value of forage is likely to go unnoticed unless we take our entire crop structure apart and carefully evaluate its various components. When severe drought hits one section of the country one of the first demands to relieve the situation is for forage for livestock from those sections having abundance. It is noteworthy that our annual grass crop production maintains a fairly even tonnage from year to year thus insuring an ever normal feed granary provided the proper care and attention is given to its preservation.

Personally, I am interested in silage but I realize that to convert all green forage material into silage is neither possible nor good economic practice. I also realize that grass must not be permitted to detract from the importance of corn, wheat, cotton, and other major crops. I do maintain, however, that the economic waste which annually occurs through past methods of grass preservation is a serious loss to our agricultural economy. If our other major agricultural crops were subjected to the same proportionate waste through handling, the results would be very serious.

It is not of primary importance as to just which mechanical methods of forage preservation will finally prevail or whether all such methods will find places on our farms. We are certain to have several different schools of thought as to how our forage crops shall be mechanized. This is healthy and encouraging. As to whether it will be ensiled, dry chopped in the field, buck-raked to the barn or stack, dehydrated, dried in the barn by forced circulation, or baled with a pickup baler will eventually be settled by the farmer and his cow.

The members of the A.S.A.E. are primarily concerned with the mechanics of agriculture, but the mechanization of any crop is so closely related to the quality of the processed crop as to make the latter a very important yardstick by which to measure the efficiency and suitability of the machine which does the processing.

Grass, in either the green state or as dry hay, is being given more mechanized attention today than at any time during the past 60 years. The large and growing amount of mechanical power now on our farms together with a critical farm labor shortage is no doubt largely responsible for the increased attention which is being given to new types of mechanized grass and hay handling equipment.

Most of the larger manufacturers of farm equipment and some of the smaller ones are experimenting with forage harvesters for both grass and forage row crops, crop blowers, pickup balers, bale loaders, etc. This engineering effort is sure to produce several machines which will find their way to our farms. That they will save much hand labor goes without saying, but unless they also serve to prevent the nutrient losses due to weather and careless handling which have plagued our hay and grass crops in the past, they will fall far short of performing their most important economic function.

I believe America's forage crop to be of sufficient importance to our agricultural economy to warrant the A.S.A.E. giving it a place at several of its major meetings. This has already been done to some extent and a continuance would seem advisable.

The A.S.A.E. has devoted considerable time and thought to postwar problems as they pertain to agriculture. Not the least among these problems will be the foreign demand for meat and milk products produced by the American farmer.

Our grass and hay after the war will be more in demand than at any time in our country's history. We shall require every pound of nutrition which our forage can produce in order that we may supply the necessary meat and milk to the undernourished, starving millions of Europe and Asia as well as help them to replenish their badly depleted herds. Quality forage, with a nutritional value as near as possible to the value it has when cut, should be the objective. The development of new grass and hay handling equipment which will produce products high in nutrition can contribute in a large measure to the task.

As I said before, it is not good economy to devote all of our attention to producing new types of mechanized grass and hay handling equipment and neglect the quality of the processed products. The one must go hand in hand with the other.

With this in mind would it not be well to devote a session of an A.S.A.E. meeting to a discussion of what really constitutes good hay and silage?

We have on the faculties and in the research departments of our land-grant colleges several excellent authorities on both hay and silage. We also have some good authorities among the personnel of USDA. Representatives of the American Hay Buyers' Association might also be called upon to tell the Society what constitutes good hay. Many of these men have devoted a lifetime to study and research and could tell the A.S.A.E. what silage and hay end-products should be. Such discussions would serve as guides for the engineers who design the grass and hay handling machines.

These discussions could be given a place on the program of the coming June meeting of the Society which could be followed by discussions of mechanized grass and hay handling problems at the next December meeting. The mechanics of the problem would by that time have had the benefit of another season's field experimental work.

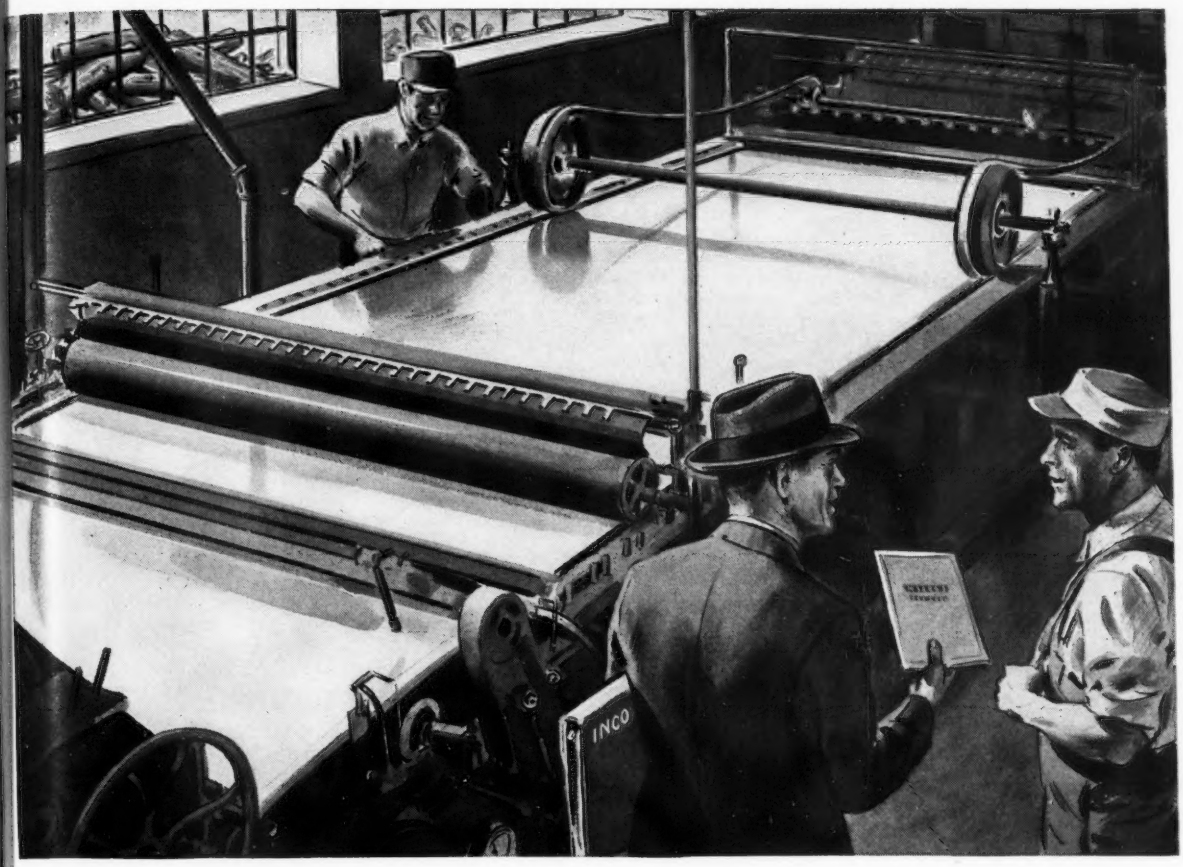
The rapidity with which grass and hay handling equipment is being developed at present will, it seems to me, tend to place the cart before the horse, unless some attention is given to the quality of the mechanically processed product. Suitable storage facilities for processed forage must also be given some attention, a problem which comes well within the province of the Farm Structures Division of the Society.

Grass silage can never reach its proper place in the farmer's feed program until more attention is given to cheap and efficient means of storage, such as trench silos. Dry chopped hay is also looking for a more efficient method of storing and handling. The pickup baler is through with its job when it discharges its package just where the forage grew. From that point to the point of feeding presents many unsolved handling and storage problems which the engineer should regard as his direct responsibility.

I submit these few observations for your consideration with the idea that they may be of some use in framing some of the future Society meeting programs.

E. W. HAMILTON

Agricultural Research
Allis-Chalmers Mfg. Co.



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A New Liquid Fertilizer Distributor

By M. A. Sharp
MEMBER A.S.A.E.

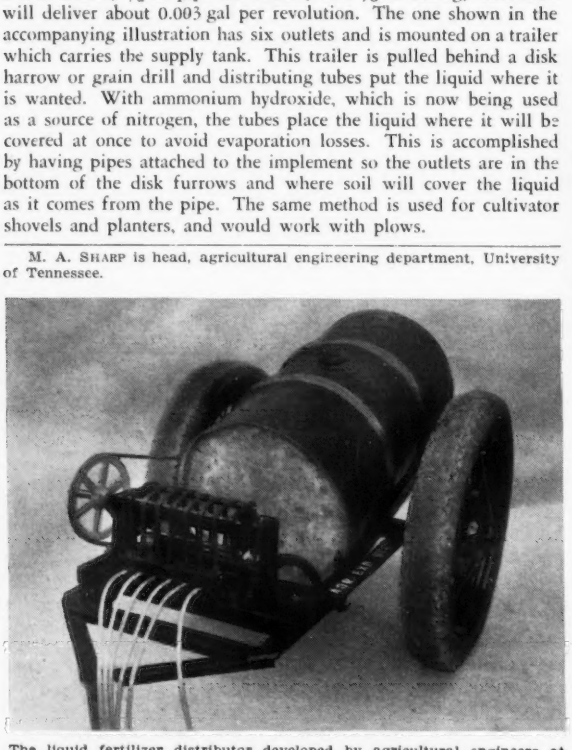
THE possibilities of distributing fertilizer in liquid form have been considered for many years. It has been practiced to a limited extent and has many advantages. Placement where it will do the most good, optimum concentration, uniform distribution, and desired volume should be obtained easily with a liquid. The difficulty has been that no satisfactory devices for metering the liquid to insure uniform distribution have been available. Gravity flow is not satisfactory because the volume changes as the pressure changes due to the difference in head in the supply tank. Variation in ground speed also causes variation in volume distributed. Small orifices to control the flow are not satisfactory because they stop up easily.

The present trend toward the use of liquid fertilizers and the need for a device which would obtain results sufficiently accurate for experimental purposes prompted agricultural engineers at the University of Tennessee to design a pump which eliminates all of the above difficulties. It is a further development of a pump designed by H. A. Arnold for adding molasses and phosphoric acid to legumes for making silage. The original pump proved satisfactory for that purpose, and the new pump has proved satisfactory for distributing liquid fertilizer within the range of use to date.

The pump consists of a piece of rubber tubing stretched in the form of a U over a revolving reel having four rollers. The tubing is collapsed over the rollers. As the reel turns the rollers move along the tube, creating a suction in the tube behind the rollers and pressure in front of them. Liquid thus is pulled into the tube and forced out under pressure. The pump may be mounted on any implement and is driven by a ground wheel. Volume delivered, therefore, is proportional to ground speed. Difference in head in the tank does not affect volume, and there are no orifices to stop up. Desired volume is obtained by varying the diameter and speed of the reel and the diameter of the tube.

The pump has a tube for each outlet desired. Using a reel with a 2-in radius, ½-in pipe for rollers, and ⅜-in tubing, each tube will deliver about 0.003 gal per revolution. The one shown in the accompanying illustration has six outlets and is mounted on a trailer which carries the supply tank. This trailer is pulled behind a disk harrow or grain drill and distributing tubes put the liquid where it is wanted. With ammonium hydroxide, which is now being used as a source of nitrogen, the tubes place the liquid where it will be covered at once to avoid evaporation losses. This is accomplished by having pipes attached to the implement so the outlets are in the bottom of the disk furrows and where soil will cover the liquid as it comes from the pipe. The same method is used for cultivator shovels and planters, and would work with plows.

M. A. SHARP is head, agricultural engineering department, University of Tennessee.



The liquid fertilizer distributor developed by agricultural engineers at the University of Tennessee

Several tank-car loads of ammonium hydroxide have been distributed by these pumps and they appear to be the answer to most of the problems involved in the application of liquid fertilizers. This is a very timely development, since recent chemical processes have made available in liquid form large quantities of nitrogen so badly needed for food production. The Tennessee Valley Authority cooperated with the Tennessee Agricultural Experiment Station in this project.

Plywood Silos

By M. A. Sharp

THE problem of winter feed for dairy cattle always has been acute in the Tennessee Valley area and became more so with the feed shortage of two years ago.

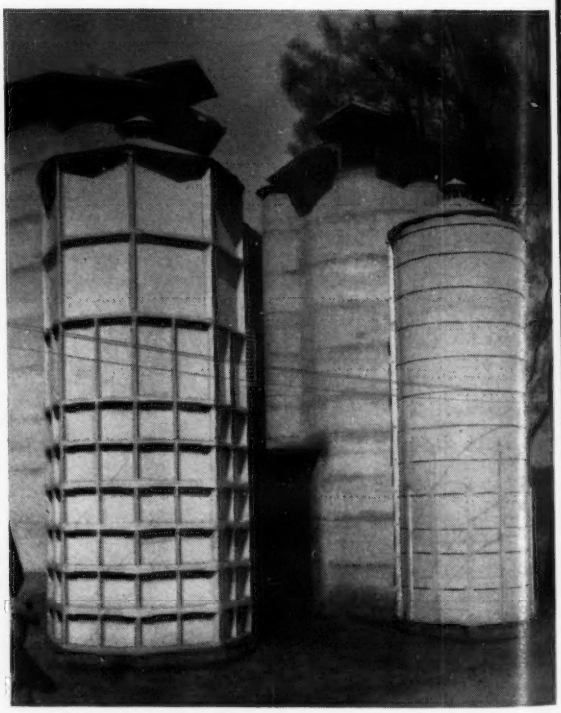
High humidity, a short daily period of sunshine, and low wind velocity make it very difficult to cure hay properly. Winter pasture cannot be depended upon entirely for feed because there are a few weeks each year when mud and cold rains make it inadvisable to keep stock on it. Small herds, usually less than ten head, and the short season during which feeding is necessary preclude the cost of large and expensive silos for most farms. Winter rains make trench silos unsatisfactory unless the silage is covered with waterproof paper, the walls and floor are lined with concrete, and ample drainage is provided.

These unfavorable factors made it appear advisable to investigate the possibilities of small inexpensive silos which would be adequate for meeting conditions in this area. One type of material which appeared to be quite promising was exterior fir plywood. Mr. J. D. Long, agricultural engineer of the Douglas Fir Plywood Association, cooperated with us, and two plywood silos were designed and constructed under the supervision of H. A. Arnold of the agricultural-engineering staff at the University of Tennessee.

There appears to be a place for prefabricated small silos which may be hauled to the farm and erected with unskilled labor. The octagon silo shown in the accompanying illustration is of this type. Panels 4 x 8 ft have all of the necessary *(Continued on page 70)*

Article prepared especially for AGRICULTURAL ENGINEERING.

M. A. SHARP is head, agricultural engineering department, University of Tennessee.



Plywood silos under test at the Tennessee Agricultural Experiment Station

ONLY the well-run, properly equipped farm can hope to reach maximum production. This means steel. Steel to build the sanitary barns and tight sheds needed to protect livestock, poultry, stored crops and farm machinery from weather-damage. Steel for fence. Steel for the efficient, modern equipment that speeds up farm work, makes it possible to accomplish far more in the same amount of time.

The government, realizing the importance of good farm buildings to the growing of more food, now permits us to manufacture a limited amount of U·S·S Roofing and Siding Sheets. But most of these farm improvements must wait until steel is released for civilian needs in greater quantities.

The superiority of our steel and steel products is widely recognized. So is the ability of our engineers and metallurgists. The experience of these men can be of invaluable help to you in your plans for improved farm machinery and tools. Because of their efforts in the designing room and laboratory, we have the widest possible range of available steels—and the knowledge of how to use them. Later, our war-stimulated research will bring you new steels—and better steels—than you have ever known. Write us about your present and future farm problems. We shall be glad to work with you.

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COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
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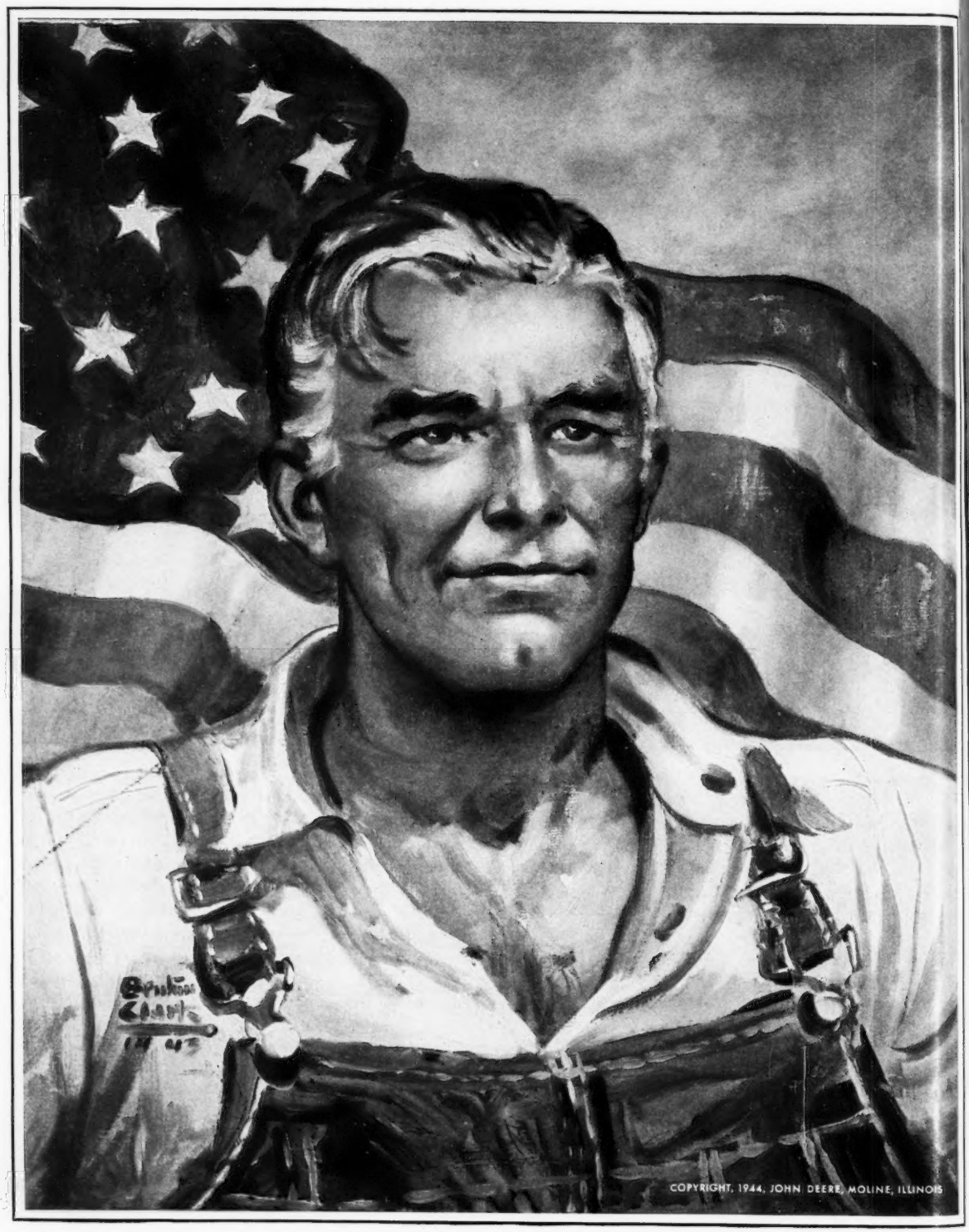
United States Steel Export Company, New York

U·S·S Steel Roofing and Siding

A favorite with American Farmers

USS

UNITED STATES STEEL



The American Farmer

We have known him for more than a hundred years...

Here at John Deere, we have walked step by step beside him and his forebears, down through those years, studying his problems and supplying his equipment needs.

We know his inheritance. It is the kind that fits men for great accomplishments. In his veins flows the blood of men who tore a civilization from the wilderness with little more than bare hands; of women who forsook comforts to face unspeakable dangers and hardships. They were inspired by the same urge that is today giving the American Farmer strength in this hour of need—a vision of freedom and the will to build a better world.

★ ★ ★

The farm has cradled the virtues and privileges that have brought into shining glory this home we call America.

The might of America today is based upon that rich heritage of a farm-born culture that is dominant in our national life. It is in our blood. It is a sustaining factor in our philosophy of living. It is an unseen, guiding force in our daily activities. In this hour of national anguish and peril, it is the solid granite for our destiny to rest upon—the foundation of strength that no crisis can unfirm.

★ ★ ★

We understand the colossal task that confronts the American Farmer in this Battle for Food, upon which largely depends the very future of civilization. It is a gigantic demand upon his full resources of strength, skill, and courage. To provide enormous amounts of meat and farm produce with a limited supply of new farm machinery, to operate his farm with little or no help—this is an undertaking that might break a weak man or stampede a timid one. But the foundation is strong. The leaven of the spirit of the old pioneer stock is mighty. Just as his forefathers met the stubborn resistance of a dormant land, subdued its wildness, ordered its progress to bring forth a great nation, so, too, their sons will preserve its freedom and greatness.

★ ★ ★

Yes, we have worked with him and his forefathers since the days of Martin Van Buren—when there were fewer than 18,000,000 people in this country and only twenty-seven stars in the Field of Blue on Old Glory. It has taught us much. It has taught us to understand his needs and respect his judgment. And, it has given us a good idea of his capacity. That long backlog of intimate experience maintains our unshakeable faith—our absolute confidence that he will come through gloriously in his job of building the fortress of food defense in this momentous Fight for Freedom.

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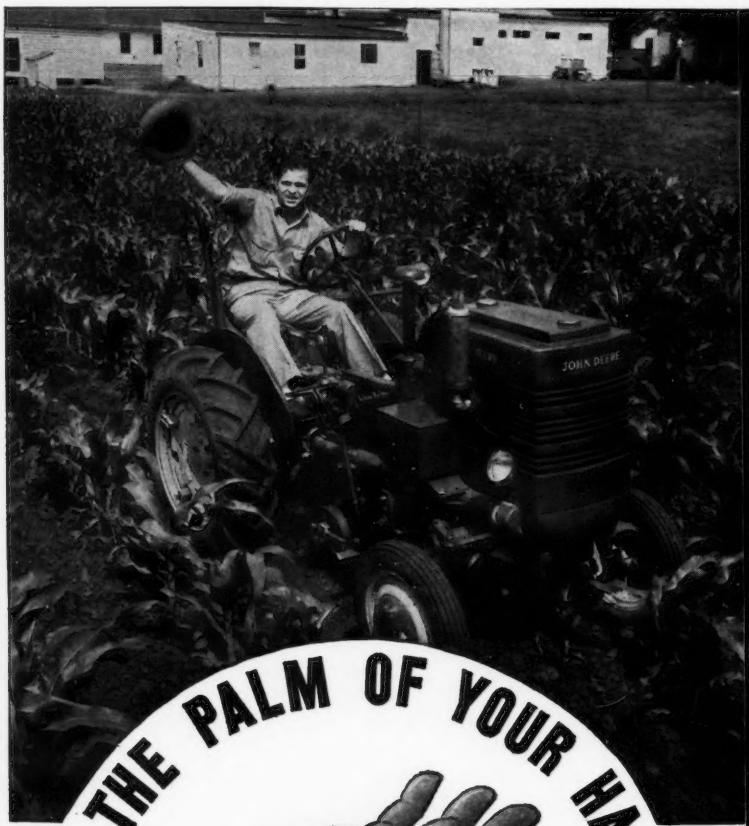
MANUFACTURERS OF QUALITY FARM EQUIPMENT FOR OVER A CENTURY



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. . . YOU CAN HOLD ENOUGH DUST TO WEAR OUT A TRACTOR, AUTOMOBILE, TRUCK OR ANY INTERNAL-COMBUSTION ENGINE.

For the past 14 years United Oil Bath Air Cleaners have protected engines from damaging abrasive action of dust and dirt-laden air — and new models of cleaners will give better protection to improved engines of tomorrow. Our knowledge and technological experience gained in furnishing hundreds of thousands of air cleaners and other units for many diverse military uses, will be reflected in an even higher standard of performance of United products after the war.

If you have on the drafting board designs for the future in which engine protection is a factor, now is the time to discuss your plans with our sales engineers. It is entirely possible that they may contribute substantially to your thinking. We invite inquiries.

The farm tractor, by increasing the productive power of agriculture, is vitally important in meeting today's challenge to produce more food. This John Deere Model LA Tractor is equipped with a United Oil Bath Air Cleaner which removes over 99% of the dust and dirt in the air . . . and adds many hundreds of important operating hours to the tractor's life.

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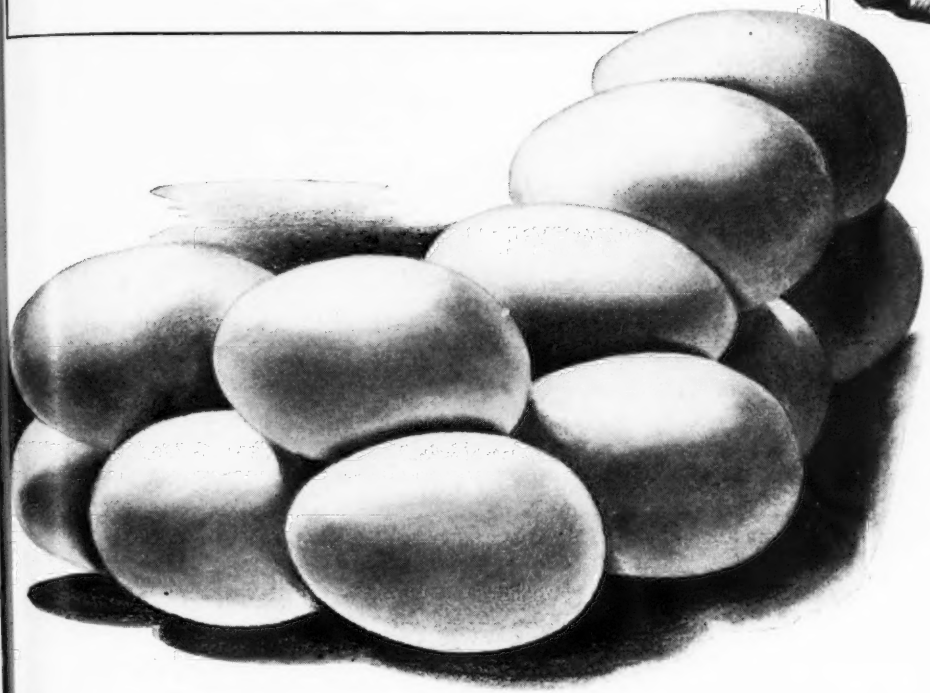
His time brought 10c more a dozen



A Western Iowa farmer found that his local hatcheryman needed better eggs. He agreed to raise the type of chickens the hatcheryman wanted, under controlled breeding, feeding, and sanitary conditions. The hatcheryman paid 10c a dozen above the market price for the eggs — because he knew they would produce better chicks. Over ten years, the farmer estimates that he has doubled his profits.

Save his time for HIS BIGGEST JOB!

Whether it's eggs, livestock or crops, farmers are learning to use their time for better production. Never was their time more valuable — with the greatest food-producing job in the world facing them this coming year.

You can help farmers in your locality by pointing out the need for concentrating on *farming*— turning over the jobs of building and repairing to experts in these fields.

HELP THEM PLAN AHEAD

Today you may be advising farmers on how to make their 1944 crop and livestock programs more productive. Or you may be working with manufacturers on the design of more efficient farm equipment and buildings — ready to be made when steels again become plentiful for agricultural purposes. Many of these products will use ARMCO *special purpose sheet steels*—which have proved their worth in silos, grain bins, stock tanks and farm machinery.

We shall be glad to send you more information about these special steels. Write for free booklets. The American Rolling Mill Company, 761 Curtis Street, Middletown, Ohio.

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Purolators are entrusted with the biggest job in oil filter history—keeping U. S. military engines *internally clean.* Tanks, ships, jeeps and planes can't fight the enemy on sludge-clogged motors. And that's where Purolators lead the world—in preventing damage by trapping dirt.

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Purolator founded the industry and is the leading manufacturer making *all* types of filters—lubricating, fuel, gasoline, hydraulic, air—the *only* manufacturer from whom many types of filters are available. If special filtration problems have you stumped, you are invited to bring them to headquarters. Purolator Products, Inc., Newark 5, N. J.

KEEP IT CLEAN with PUROLATOR

FOOD FIGHTS FOR FREEDOM

NEWS SECTION

A.S.A.E. Meetings Calendar

February 17 — Pacific Coast Section, Farm Credit Bldg., University of California, Berkeley, Calif.

March 10 and 11 — Southwest Section, Baker Hotel, Dallas, Tex.

June 19 to 21 — Annual Meeting, Hotel Schroeder, Milwaukee, Wis.

December 11 to 13 — Fall Meeting, Stevens Hotel, Chicago.

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GERMANY SURRENDERS
Hitler, Goebels, Himler in Allied Hands
Allied Countries Wild with Jubilation

—More Food Production
More Buying of War Bonds
WILL MAKE THESE HEADLINES TRUE

The day's coming, let us hope soon, when these headlines can be written.

Germany made enemies by robbing conquered countries of essential food. America is making friends by producing food. And the need for more food and still more food gets greater.

On tens of thousands of farms, Jamesway Barns and Equipment are helping to meet wartime food goals . . . and giving farmers extra income to buy more War Bonds.

For thirty-five years, more than 50,000 farmers have bought Jamesway Equipment and Housing each year to make farming easier, better, more profitable.

Jamesway Cuts Chore Time . . . Increases Production

Today, in the barn, a Jamesway Litter-Carrier cuts chore time in half — enables a boy to do the work of a man. Automatic waterers increase milk production 5 to 10 per cent. New type stalls and stanchions save time in cleaning the barn . . . give more elbow room to the milker . . . assure more comfort for the cow.

In the hog lot, the Jamesway is saving feed, getting meat animals to market in less time. In the hennery it saves time and work . . . enables you to handle more birds in less space . . . to have thriftier, higher producing flocks.

See your Jamesway Dealer

Check with him for your Jamesway Equipment needs. Furthermore, the Jamesway man will be glad to go over your problems with you and help you plan now for the modern, efficient layout you want when the war is over. Shall we have him call?

JAMES MFG. CO., Dept. A-244
Fort Atkinson, Wis.
Elmira, N. Y. **Oakland, Calif.**

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BARN, POULTRY AND HOG HOUSE EQUIPMENT, SELF FEEDERS AND VENTILATION.

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MORE MILK-EGGS-MEAT

Purolators are entrusted with the biggest job in oil filter history—keeping U. S. military engines *internally clean.* Tanks, ships, jeeps and planes can't fight the enemy on sludge-clogged motors. And that's where Purolators lead the world—in preventing damage by trapping dirt.

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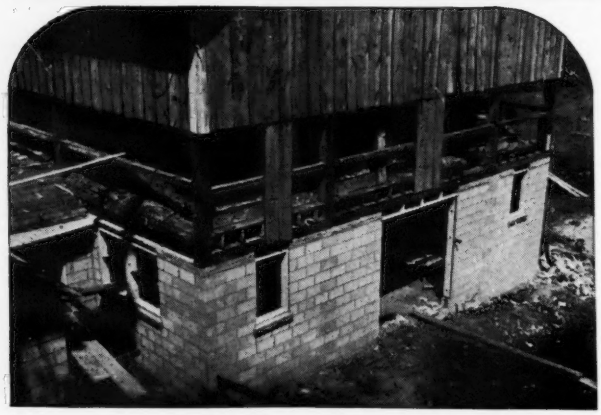

A sanitary concrete floor and new concrete masonry walls converted this old farm structure into a modern dairy barn. New concrete milk house (at left) was built at same time.

CONCRETE RESTORES BARN

for years more service

This old dairy barn, which was fully restored with concrete to function for many years more, is an example of the helpful war service being performed by agricultural engineers.

Farm structures, like war factories, are fighting equipment. Every improvement which helps the farmer increase production makes gains on the fighting front that much easier.

Many essential facilities which save labor for the farmer, help him produce and preserve more food, can be built of concrete without the use of critical materials. Such necessary improvements as sanitary milk houses, concrete dairy barn floors, paved barnyards and feeding floors or firesafe, ratproof storehouses are more important than ever before.

Our engineers, backed by facts gained from years of scientific research and field experience, are ready to help you on any concrete farm building design or construction problem.

PORTLAND CEMENT ASSOCIATION

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A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

BUY MORE WAR BONDS

Out of the 16 members of this committee of advisors, five are members of the American Society of Agricultural Engineers: Kirk Fox, editor of Successful Farming; Frank Kranick, J. I. Case Company; E. W. Lehmann of the University of Illinois; D. G. Womeldorff, of the Public Service Company of Northern Illinois, and V. S. Peterson of the DuPont Company. Mr. Peterson is also chairman of the A.S.A.E. Committee on Farm Safety.

Personals of A.S.A.E. Members

Joseph R. Bodwell, recently resigned as rural sales supervisor of the Public Service Company of New Hampshire, to become manager of the electrical division of the Merrimack Farmers' Exchange, Inc., of Concord, N. H.

M. M. Jones, professor of agricultural engineering, University of Missouri, is author of Circular 282, entitled "Saving Gasoline on the Farm", recently issued.

E. M. Mervine has resigned as agricultural engineer of the Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, to accept appointment as professor of agricultural engineering, Colorado State College, Fort Collins. He will sponsor the agricultural engineering work of that institution.

H. Lee Vanderwilt recently accepted a position as tractor engineer with the Ethyl Corporation of Tulsa, Oklahoma. He was previously appeals analyst, tools and hardware section, War Production Board, Washington.

Necrology

J. W. EVANS, a district rural supervisor of the Farm Security Administration, U. S. Department of Agriculture, according to word received recently, passed away at his home in Weslaco, Texas, on June 3, 1943.

Mr. Evans was born at Aledo, Texas, June 20, 1886. He has been associated during the past ten years with the Farm Security Administration as the district supervisor of the Lower Rio Grande Valley of Texas. In this work he was instrumental in influencing a number of cooperative enterprises in the way of irrigation, farmers' meat processing plants, feed mills, oil mills, and other processing plants, thereby creating many additional cash crops in the communities affected. His cooperative work was recognized both by the regional and Washington offices of FSA, and a few years ago he was put in charge of the industrial cooperative work for the region embracing the states of Texas and Oklahoma.

Mr. Evans had the distinction of operating the first farm in Texas, during World War I, without horses or mules, motor cultivators and tractors being used exclusively as the power units.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Leonard W. Acker, agricultural engineer, Louden Machinery Co. (Mail) 11 Rokeby Ave., Garrett Park, Md.

Ben Butterworth, general manager, John Deere Plow Works, Moline, Ill.

Robert I. Denny, development engineer, Wood Bros. Thresher Co., Des Moines, Iowa, (Mail) E. 14th & Canary.

Alvin H. Hollenberg, special representative, agricultural education service, U. S. Office of Education, Washington, D. C.

Charles S. Morrison, Lt. (jg), USNR, laboratory superintendent, Radio Material School (SPS), Naval Research Laboratory, Washington 20, D. C.

J. P. Page, rural division supervisor, Quebec Power Company, Quebec, Canada. (Mail) 229 St. Joseph St.

B. G. Perkins, farm manager, Doane Agricultural Service, Inc., St. Louis 12, Mo. (Mail) 8983 St. Louis Ave.

F. Y. Porter, junior agricultural engineer, Soil Conservation Service, USDA. (Mail) General Delivery, Jay, Okla.

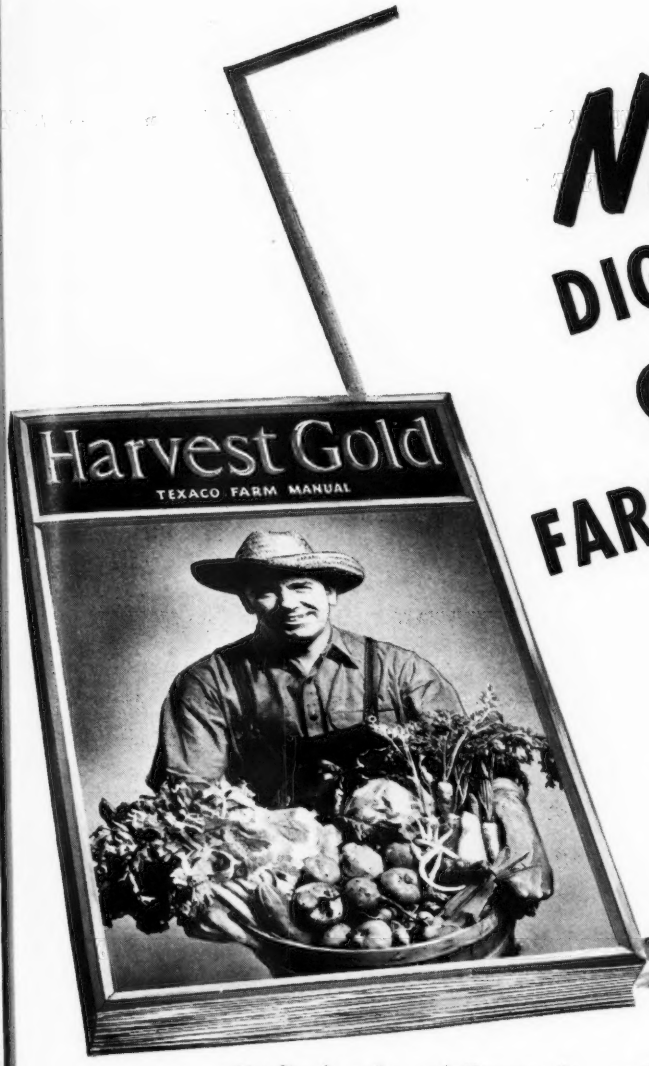
Eugene R. Whitacre, engineer amphibian command, U. S. Army. (Mail) 1817 Hewitt Ave., Cincinnatti, Ohio.

TRANSFER OF GRADE

Jesse B. Brooks, extension agricultural engineer, University of Kentucky, Lexington, Ky. (Junior Member to Member)

L. H. Skromme, assistant executive engineer, Harry Ferguson, Inc., Dearborn, Mich. (Mail) 22204 Audette. (Junior Member to Member)

Harold J. Thompson, Lt., 736 Engr. Hu. Shop Co., USA, Camp Clairborne, La. (Junior Member to Member)



NEW DIGEST ON CARE OF FARM MACHINERY FREE FOR FARMERS

Credit for the excellence of this New Edition of Harvest Gold, Texaco's Farm Machinery Manual, goes to the twenty-five leading Agricultural Engineers who helped prepare it.

It is the first "digest" on machinery care by qualified authorities who not only suggested what this manual should contain but supplied most of the material. The former edition has been distributed to hundreds of thousands of farmers in all 48 states. It is being used as a standard reference book in a number of leading Agricultural Colleges and Vocational Schools. The New Edition is 130 pages, contains new material. It is a valuable reference book for farmers because it tells not only how to avoid farm machinery troubles but what to do when troubles come.

The new manual is offered free to all whom it will help. It represents a real contribution from Agricultural Engineers to ease the task of the hardest worked man in America—the Farmer. Copies can be obtained free. Write the nearest Texaco office listed below.

TEXACO

WIN THE WAR ON WEAR WITH **TEXACO PRODUCTS** FOR THE **FARM**

DISTRICT OFFICES: Atlanta 1, Ga.; Boston 17, Mass.; Buffalo 3, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 1, Colo.; Houston 1, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 2, Minn.; New Orleans 6, La.; New York 17, N. Y.; Norfolk 1, Va.; Seattle 11, Wash.
Texaco Products also distributed by McColl-Frontenac Oil Co., Ltd., Montreal, Canada

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the address indicated.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE INDIANA STATION. (Partly coop. USDA et al). Indiana Ag. Exp. Sta. (Lafayette) Rpt. 1941. This report contains notes on a study of the suitability of earth stabilized with emulsified asphalt for farm building construction as applied to a poultry laying house, and poultry housing studies, both by I. D. Mayer and C. W. Carrick; atmospheric corrosion of wire and wire products, and factors entering into the storage of shelled corn with high moisture content in small wire-sided bins, both by Mayer, study of temperature, humidity, and air movement in a concrete dairy barn, by Mayer and J. H. Hilton; hydrologic studies and measurement of runoff from small watersheds, by R. B. Hickok, Mayer, H. Kohnke, and G. D. Scarseth; a study of the structural and economic factors involved in the use of plywood in hog houses and poultry houses, by Mayer, E. J. Kirsch, C. M. Vestal, J. H. Martin, and Carrick; studies with Purdue plow trash shields, and a study of a fertilizer attachment for plows, both by R. H. Wileman; investigations on weed control implements, by Wileman and O. C. Lee; seed corn drying investigations, by Wileman and A. J. Ullstrup; the use of electricity in brooding chicks, by T. E. Hienton, S. W. Hinners, and W. P. Albright; mechanical refrigeration of milk with units driven by gasoline engines and electric motors, by Hienton and R. L. Witz; use of mechanical refrigeration for cooling and holding eggs on the farm, by Hienton, Witz, and G. W. Newell; a study of the use and practicability of electric heat for warming drinking water for livestock, by Hienton, G. H. Foster, and C. F. Gobble; the use of electric heat in brooding early spring farrowed pigs, by Hienton, Foster, and C. M. Vestal; a study of equipment and methods for freezing and storing farm produce, by G. M. Redfield and Witz; the development of portable driers for the dehydration of hay and grain, by W. Aitkenhead, Wileman, and Mayer; and power consumption and comparative costs of stationary and portable spraying and stationary v. portable spraying plants, by C. L. Burkholder and Hienton.

ADAPTING HORSE-DRAWN MOWERS TO TRACTOR POWER, *L. E. Hightower*. Missouri Ag. Exp. Sta. (Columbia) Cir. 217 (1941). The author notes that the mower attached to the tractor should not be hitched directly to the end of a stub tongue. The brace bar beneath the frame extends downward at an angle , and in heavy cutting an upward thrust is produced. This tends to lift the weight of the mower frame off the wheels and thereby cause slippage. A drawing shows an arrangement which permits the mower to be pulled from the regular doubletree hitch. About one-half the force required to pull the mower is applied, through the draft rod, to the yoke of the cutter bar. This type of hitch allows much heavier cutting to be done without adding weight to the mower to provide traction. Square turns are possible if the regular tractor drawbar is extended backward about 18-20 in in a manner illustrated. The tractor must be turned very short just as the rear tractor wheel clears the corner of the land. It may be necessary to use the right wheel brake. It is not necessary to stop the tractor, and it is usually not necessary to lift the cutter bar on square corners. Some safety device should be provided in the hitch unless the operator is sure the cutter bar will encounter no obstruction. Figures show one very simple type of safety device. It consists of a small rivet or nail which shears and allows the drawbar extension to slide through the clamps which hold it to the tractor drawbar. A satisfactory arrangement for lifting the cutter bar from the tractor seat is illustrated.

SPRAY MACHINERY FOR HOME ORCHARDS, GARDENS, AND TRUCK CROPS, *T. E. Ashley*. Mississippi Ag. Exp. Sta. (State College) Cir. 106 (1942). The author describes various commercial types of hand and power-operated sprayers; gives details of the construction and operation of a hand-pump barrel sprayer converted for ½-hp gasoline motor drive, of which setup a similar description has previously been published, together with directions for making a hemicylindrical horizontal sprayer tank; takes up nozzles for sprayers; briefly notes dusting equipment and its use; and adds some discussion of spraying schedules for various fruits.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE MASSACHUSETTS STATION, Massachusetts Ag. Exp. Sta. (Amherst) Bul. 388 (1942). These included a cranberry storage investigation by C. I. Gunness, H. J. Franklin, and C. R. Fellers; an apple storage investigation, by Gunness; and a poultry house investigation, by Gunness and W. C. Sanctuary.

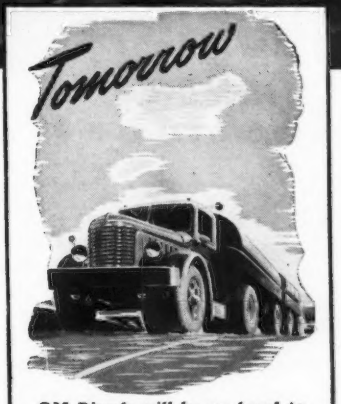
HOW Important Are
WHEELS and AXLES?
No matter how good you make your Portable Units, the user will not enjoy its ultimate satisfaction unless he can handle it speedily — efficiently — and with complete confidence.
That means that Wheels — good Wheels — are a vital part of your assembly. Let our Engineers show you how to make the most of the good Wheels we can produce for you. Write today for complete Illustrated Bulletins, covering wheels of every type — for every need.
EWC WHEELS
Electric Wheel Co., Dept. AE, Quincy, Ill.

WHEN THERE'S WORK TO BE DONE —IN WAR OR PEACE

YOU will find GM Diesels hard at work in every theater of the war. They power massive tanks moving into battle, heavy trucks in endless supply lines, tractors to clear landing fields, landing and assault boats, big submarines and fast subchasers in home and in foreign waters.

In every respect, these GM Diesel Engines are living up to all that was predicted for them—and more. In many instances they are doing an even greater variety of jobs than they were designed for. They are standing up under conditions that couldn't possibly have been foreseen.

When the war is over, GM Diesels will be ready to serve the peace as they are serving in war. With this difference: expanded production facilities, together with improvements and refinements in design and construction, will make them even more available for use—more capable of reliable, low-cost performance.



GM Diesels will be on hand to show that they can do an even bigger job in America's trucks. Simple in mechanical construction; sturdily and precisely built; economical in operation and upkeep, GM Diesels will prove as indispensable in peace as they are proving vital in war.

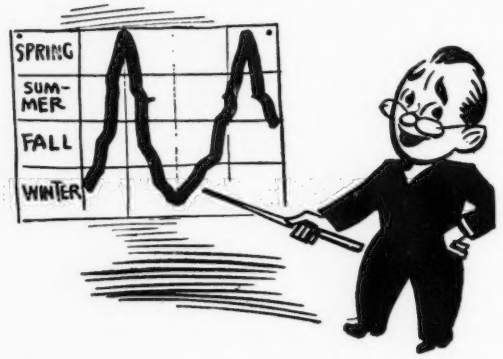
GM
GENERAL MOTORS
DIESEL POWER

ENGINES..15 to 250 H.P... **DETROIT DIESEL ENGINE DIVISION,** Detroit, Mich.

ENGINES..150 to 2000 H.P...CLEVELAND DIESEL ENGINE DIVISION, Cleveland, Ohio

LOCOMOTIVES.....ELECTRO-MOTIVE DIVISION, La Grange, Ill.

OVERHAUL
BETWEEN SEASONS



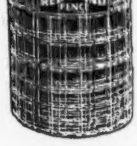
Agricultural engineers will agree that it's just plain common sense to get every tractor and farm machine overhauled between seasons — when they are needed least. International Harvester dealers are working overtime these days to take care of important, necessary service work. Count on them to help the farmer produce more food in 1944.

INTERNATIONAL HARVESTER COMPANY
180 North Michigan Avenue **Chicago, Illinois**

"GOOD FENCE
is the First Step in Improving a Farm"

. . . says Clyde Brooks, Iowa Falls, Iowa

"When I took over this farm 12 years ago, the fences were poor and there were only a dozen head of livestock on the entire 200 acres. Crop yields had been steadily decreasing, too. Since then I have fenced the entire farm, stocked it heavily, and brought legume pasture into the rotation. As a result, corn yields have increased 20 bushels per acre during the past 12 years, and I now have a profitable livestock setup besides."



More Fence Now Available

More and more Keystone fencing materials are now being shipped to dealers, due to recent government releases of steel for fence-making purposes. Keystone's present fence, while not marked with the familiar Red Brand, is firmly woven of copper-bearing steel wire, well galvanized, and good for many years of satisfactory service.

KEYSTONE STEEL & WIRE CO., PEORIA, ILLINOIS

RED BRAND FENCE
and RED TOP STEEL POSTS

Vertical Diversifications

(Continued from page 38)

dollar, and whether they should do it as individuals, co operatives or corporations no doubt are questions much broader than engineering. Yet the cost and the quality of every operation are essentially matters of agricultural engineering. On the basic premise that efficiency and stability eventually benefit the whole people, we should provide such service as will give vertical diversification a fair trial.

Plywood Silos

(Continued from page 58)

framing the attached to them in the shop. These panels are then taken to the building site and may be quickly assembled with unskilled labor. The only operation to be performed is to put glue on gusset plates and drive a few nails in the plate. The door guides may be made in sections or in one piece as preferred. The roof may be made in sections and bolted to the plates.

The round silo shown was constructed at the site and involved some difficulty in bending the bands on the 8-ft diameter which was used. There is no steel in either silo, except bolts used across the doors on the round one which could be eliminated by the use of dowel rods. The 4x8-ft panels have the horizontal joints staggered. The door jambs are oak 4x4's, and oak 2x4's are placed vertically around the bottom to keep the silo from blowing over when empty. Experience indicates that these 2 x 4's need not be over 4 ft long. This silo was assembled with waterproof glue and was held together with shingle nails while the glue set.

All plywood used on both silos is ¼ in thick, except the gusset plates on the octagon and the doors which are ¾ in thick.

Both silos have continuous openings and a series of slide doors 2 ft high. It is therefore necessary to remove only the top door and thereafter each door is moved up 2 ft, leaving an opening at the silage level.

These silos are approximately 8 ft in diameter and 24 ft high. The octagon silo was treated inside with a coat of linseed oil followed by hot asphalt. This has not proved to be satisfactory because the asphalt was applied in a heavy layer which is rough and tends to prevent the silage settling. The round silo was treated inside with two coats of linseed oil and appears to be satisfactory so far as can be observed at the top.

The silos were both filled in October 1942, the octagon silo with soybeans and the round one with sorghum and corn. The bean silage was fed in the spring of 1943 and was excellent. There was no spoilage of consequence around the sides or doors. The corn and sorghum silage is still in the round silo. Neither of these silos show any signs of deterioration at any point. Plans are made to construct a larger round silo as soon as materials are available.

The octagon silo appears to be adaptable for prefabricated construction, but the round silo involves construction problems which need further investigation before recommendations can be made. It appears that the glue will carry the stress loads.

This project is cooperative between the Tennessee Agricultural Experiment Station, the Douglas Fir Plywood Association, and the Tennessee Valley Authority.

PROFESSIONAL DIRECTORY

Consulting Engineering Work In Farm Structures Field
Also Sales Engineering for Selected Manufacturers

George R. Shier, A. E.

Member A.S.A.E. Associated with Howard S. Sterner Company, Consulting Structural Engineers, 30 East Broad Street, Columbus, Ohio

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

Buy War Bonds

℞ ...for Rusty Roofs

Here is a sure remedy to renew the utility and appearance of galvanized roofing sheets that show a tendency to rust:

Apply . . .

METALLIC ZINC PAINT

This truly remarkable paint has proved its worth in many a practical test. The rust-inhibitive and preventive power which Zinc possesses as a coating on galvanized sheets is carried into the paint itself through the metallic Zinc dust in the pigment. METALLIC ZINC PAINT applied to metal roofing sheets at the first sign of rust will completely stop it for many years—the durability of the paint is amazing.

For best results, follow the formula in Federal Spec. TT-P-641 as prepared by the U. S. Bureau of Standards.

How to Make GALVANIZED ROOFING Last Longer

As part of its contribution to the campaign for conservation of materials and to the "Food Fights For Freedom" Program, the Zinc Institute has prepared two booklets of special value to anyone who desires to maintain the utility and appearance of galvanized roofing practically indefinitely:

1-"METALLIC ZINC PAINT"

2-"HOW TO MAKE GALVANIZED ROOFING LAST LONGER"

These booklets are being distributed free, and a postal request will bring copies to you.

AMERICAN ZINC INSTITUTE
INCORPORATED
60 East 42nd Street • New York 17, N. Y.

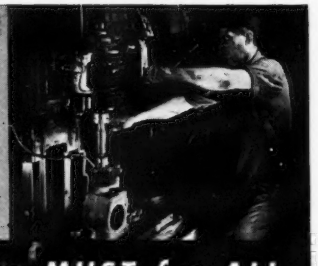
BUILDINGS

Are Important In Food Production

Our country will be called upon in 1944 for the greatest food production in history. Industry as well as agriculture has its duty to perform in the great "Food Fights For Freedom" program. Many buildings, both on farms and in industrial areas, are used for food storage and processing, and the maintenance of these buildings so as to provide safe and adequate storage and shelter is highly important.

KEEP YOUR WAR EQUIPMENT FIT AND FIGHTING — FOOD FIGHTS for freedom

Buildings Are War Equipment Keep Them Fit and Fighting



MIRROR-FINISH CYLINDER HONING

is a Production MUST for ALL

WISCONSIN ENGINES

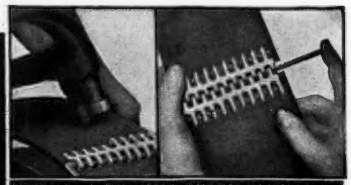
Yes . . . even the little Model AA 1 hp., single-cylinder Wisconsin Air-Cooled Engine has its 2¼"-bore cylinder honed to a high mirror finish . . . to assure smooth, full-power operation and maximum fuel and maintenance economy.

No "hidden detail" of design and construction is neglected or sacrificed to "price expediency" in the manufacture of these fine engines. These details are important to YOU in the operation of *your equipment*. Wisconsin air-cooled engine power is the answer.

Most H.P. per pound

WISCONSIN MOTOR
Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

BELT LACING and FASTENERS for transmission and conveyor belts



"JUST A HAMMER TO APPLY IT"

ALLIGATOR
Trade Mark Reg. U. S. Pat. Office
STEEL BELT LACING

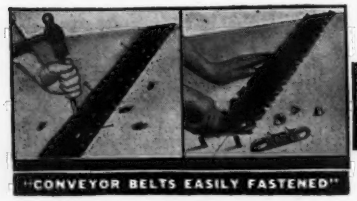
World famed in general service for strength and long life. A flexible steel-hinged joint, smooth on both sides. 12 sizes. Made in steel, "Monel Metal" and non-magnetic alloys. Long lengths supplied if needed. Bulletin A-60 gives complete details.

FLEXCO HD
BELT FASTENERS AND RIP PLATES

For conveyor and elevator belts of all thicknesses, makes a tight butt joint of great strength and durability. Compresses belt ends between toothed cupped plates. Templates and FLEXCO Clips speed application. 6 sizes. Made in steel, "Monel Metal", non-magnetic and abrasion resisting alloys.

By using Flexco HD Rip Plates, damaged conveyor belting can be returned to satisfactory service. The extra length gives a long grip on edges of rip or patch. Flexco Tools and Rip Plate Tool are used. For complete information ask for Bulletin F-100.

Sold by supply houses everywhere



"CONVEYOR BELTS EASILY FASTENED"

FLEXIBLE STEEL LACING CO.
4677 Lexington St.
Chicago, Ill.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEER wanted on a 15,000-acre vegetable farm in southern New Jersey. The position will be that of assistant to the farm superintendent and will include the work of directing the maintaining and repairing of farm buildings and operating equipment. Applicants should have an engineering education as well as considerable practical experience with farm operating equipment and buildings. In addition to repair work, the job will include responsibility for occasional new building construction which will call for actual construction experience and ability to lay out and design farm structures as well as supervise their construction. The farm equipment includes 300 dwellings with all the barns and sheds that go with them, 40 Caterpillar Diesel tractors 60 Farmall tractors, and all the necessary miscellaneous farm equipment, together with a large fleet of trucks. The position can be enlarged or contracted to suit individual abilities. Salary $3000 to $4800 depending upon individual qualifications. PO-149

ENGINEERS WANTED in our plants in CALIFORNIA, FLORIDA, ILLINOIS and other states. Must have had at least three years' experience in general machine design. Our work is postwar development of machines for use in agriculture and in fruit and vegetable canneries, packing houses, and processing plants. Please give full history, including family, also name of state in which you prefer working, and salary expected — also snapshot of yourself if available. Reply to Food Machinery Corp., San Jose, California.

AGRICULTURAL PRODUCT ENGINEER for mechanical designing and development of corn pickers, combines, and other harvesting machines. Permanent position with old, well-established Midwest manufacturer with national distribution. Located in fine city with adequate housing and educational facilities. Big postwar farm market assures future. Salary open. Write experience, qualifications, draft status, and other particulars in your letter. PO-147

AD COPY WRITER wanted. Man with some technical experience who is creative and has the knack of writing simple, forceful copy for industrial and technical advertising is desired. Permanent position and good opportunity for advancement with long-established 4-A advertising agency. Correspondence will be kept confidential. PO-146

RESEARCH ENGINEER wanted for design and development of agricultural machinery and equipment for the Southeast. Salary up to $3,000, depending on qualifications. Persons interested are requested to write giving full particulars regarding training, experience, and other pertinent information. PO-141.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B.S. and M.S. degrees in agricultural engineering and economics, with experience in resident teaching, extension, and research work at two eastern universities, 29 years of age, farm reared, in good health, and whose draft status is 3-D, would be interested in a position teaching agricultural engineering with an opportunity to do research work at some university, or would consider a position with a farm machinery or public utilities company. PW-358

AG ENGINEERING GRADUATES (two) who will receive their B.S.A.E. degrees from Virginia Polytechnic Institute March 25, desire employment. Both 21 years of age, farm reared, single, available on graduation. One draft exempt, the other classified 2-A. Both have civil service rating of junior agricultural engineer; one primarily interested in farm machinery and structures and the other in soil and water conservation, drainage, and land reclamation. Address Agricultural Engineering Department, Virginia Polytechnic Institute, Blacksburg.

AGRICULTURAL ENGINEER with B. S. in both agriculture and mechanical engineering from midwestern university. Some graduate work in engineering. Desires position in college teaching, research, or extension, or with private concern. Has had experience in soil conservation, farm machinery and equipment, farm structures, and rural electrification. At present employed as a state extension agricultural engineer. Farm reared. Married. Age 38. Good reason for desiring a change of position. References and professional record available upon request. PW-357